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Rutherford

ELECTRONICS CO.

PULSE GENERATOR

MODEL B7F

QUALITY LABORATORY V. A. B. RM. 303

CULVER CITY,
CALIFORNIA

3176

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LABORATORY
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PULSE GENERATOR

MODEL B7F

Serial No. F695

Price $5.00

Rutherford
ELECTRONICS CO.
P. O. Box 472
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TABLE OF CONTENTS

	PAGE NO.
GENERAL DESCRIPTION	1
SPECIFICATIONS	3
OPERATING INSTRUCTIONS	4
Preliminary Instructions	4
Front Panel Controls	5
MAINTENANCE	7
Calibration	8
Trouble Shooting	8
Calibration Chart	9
CIRCUIT DESCRIPTION	10
Oscillator Section	10
Delay Section	10
Width Section	11
Start Pulse Channel	11
Stop Pulse Channel	11
Output Section	11
Power Supply Section	12
CIRCUIT THEORY	12
Free-running Multivibrator	12
Monostable Multivibrator	13
Blocking Oscillator	14
Schmitt Trigger	14
PARTS LIST	17
COMPONENT REPLACEMENT	21
WARRANTY	21
CIRCUIT BLOCK DIAGRAM ---------- following	21
CIRCUIT SCHEMATIC DIAGRAMS - following CIRCUIT BLOCK DIAGRAM	

PULSE GENERATOR

MODEL B7F

GENERAL DESCRIPTION

The model B7F is a compact, lightweight, general purpose pulse generator designed to meet the rigid requirements of a great number of research and test applications. Exacting design criteria, an electron tube complement of a small number of tube types, and special duty cycle limiting circuitry to automatically protect the output tubes from life-shortening overloads insure long periods of reliable operation with a minimum of maintenance and repair problems.

The model B7F is capable of either single or double pulse operation, by front panel control.

In the single pulse mode, the model B7F produces trains of 50 volt pulses having repetition rates to 2 megacycles, pulse delays and widths to 10,000 microseconds, rise and fall times of 15 millimicroseconds, and a permissible duty factor of up to 30% at full amplitude.

In the double pulse mode, the model B7F produces pulse pairs having the same characteristics mentioned above, with the limitation that the minimum pulse to pulse spacing of the two pulses be 0.5 microseconds or greater, and that the duty factor limitation applies to the sum of the two pulses within the pair.

The model B7F generates these pulse trains in the following manner. (Refer to Fig. A for time relations of the various pulses.)

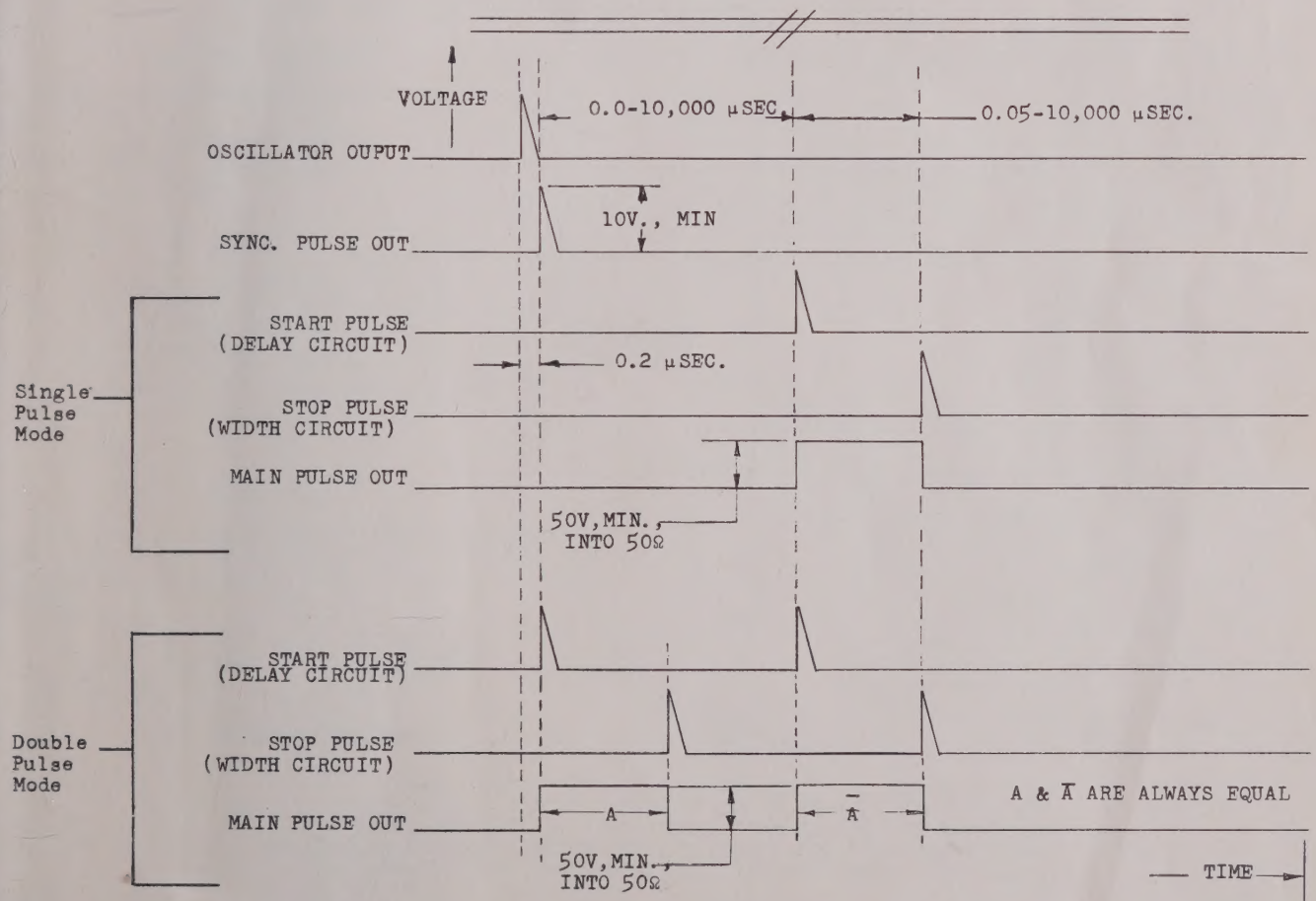


Fig. A TIMING DIAGRAM

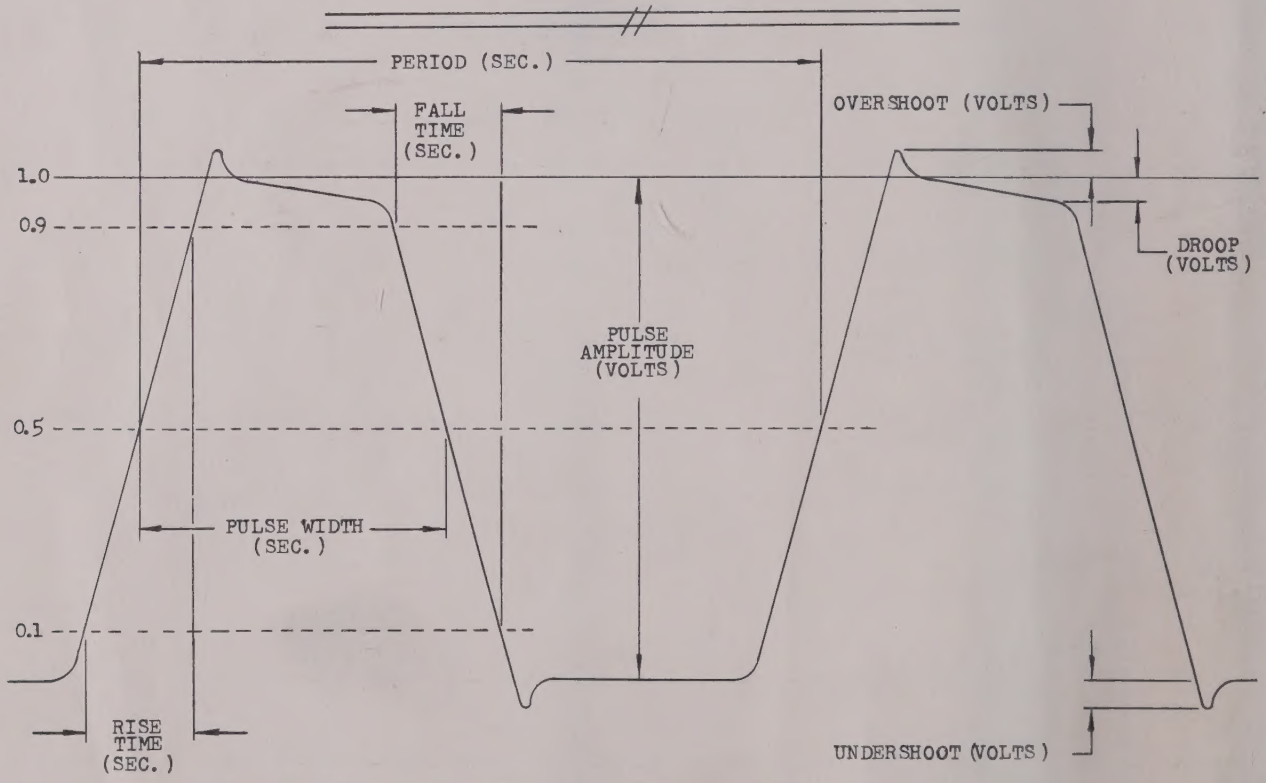
In the single pulse mode, the oscillator section creates a continuous train of timing pulses to establish the repetition rate of the output pulse. These timing pulses are used to start delay circuitry to produce what we shall call a start pulse. The start pulse occurs at the end of a time predetermined by the pulse delay controls. The start pulse is used to form the leading edge of the output pulse and to start another delay circuit which produces a second pulse called the stop pulse. This stop pulse occurs at the end of a time predetermined by the setting of the pulse width controls and is used to form the trailing edge of the output pulse. A clamp tube, which is cut off at the time the start pulse occurs, and back on again when the stop pulse occurs, creates what is used as a fill-in pulse between the start and stop pulses. The basic output pulse is therefore created by turning the main pulse on with the start pulse, keeping it on with the fill-in pulse, and turning it off with the stop pulse.

In the double pulse mode of operation, the same techniques are used except that the oscillator output pulse is sent simultaneously to the delay multivibrator and the delay blocking oscillator sections, thus starting one output pulse at essentially time zero and another one after the time determined by the delay controls. Of course, the width control setting determines the width of both pulses.

The pulse forming circuitry then amplifies the power of this pulse and presents it through suitable attenuation and polarity determining circuitry as the main output pulse.

Supplementary circuitry furnishes a synchronizing pulse from the oscillator section for use in synchronizing additional instrumentation with the main output pulse of the generator, a means of triggering the generator from an external source so that it may be synchronized with other instruments, and a means of varying the rise and fall times of the output pulse for applications requiring degraded pulse shapes.

Past experience has indicated confusion concerning the definition of some of the basic terminology used in reference to pulses. Fig. B shows these terms as defined by accepted IRE standard pulse terminology. When used in this manual, these terms are meant to be as defined by this standard.



REPETITION RATE (PULSES/SEC.) = 1/PERIOD (SEC./PULSE)
DUTY FACTOR (%) = PULSE WIDTH (SEC.)/PERIOD (SEC.) 100
OVERSHOOT (%) = OVERSHOOT (VOLTS)/PULSE AMPLITUDE (VOLTS) 100
UNDERSHOOT (%) = UNDERSHOOT (VOLTS)/PULSE AMPLITUDE (VOLTS) 100
DROOP (%) = DROOP (VOLTS)/PULSE AMPLITUDE (VOLTS) 100

FIG. B DEFINITIONS OF BASIC PULSE TERMINOLOGY

SPECIFICATIONS

The following are the design specifications of the model B7F pulse generator. The instrument will, in most cases, exhibit properties which are superior to the specifications.

OSCILLATOR REPETITION RATE

The internal oscillator is continuously variable from 2 cycles per second to 2 megacycles per second in six ranges

2 cps	-	20 cps
20 cps	-	200 cps
200 cps	-	2 kc
2 kc	-	20 kc
20 kc	-	200 kc
200 kc	-	2 mc

EXTERNAL TRIGGERING

In addition to the internal oscillator, the model B7F may also be triggered from an external source by a trigger exhibiting the following characteristics.

AMPLITUDE	20V., minimum
REPETITION RATE	2 mc, maximum
RISE TIME	1.0 µsec. or less
POLARITY	Positive or negative

NOTE: At lower repetition rates and/or faster rise times, the instrument triggers with a much lower amplitude pulse. The fast rise time quality of the sync. pulse out allows the model B7F to be triggered from the sync. pulse from another model B7F at all repetition rates.

PULSE DELAY

Main pulse delay is continuously variable, with respect to the sync. pulse out, from 0.0 microseconds to 10,000 microseconds in five ranges.

0.0 µsec.	-	1.0 µsec.
1.0 µsec.	-	10 µsec.
10 µsec.	-	100 µsec.
100 µsec.	-	1,000 µsec.
1,000 µsec.	-	10,000 µsec.

NOTE: In the double pulse mode, the first pulse is fixed at approximately zero delay. The second pulse is delayable from 0.5 to 10,000 microseconds with respect to the leading edge of the first pulse.

PULSE WIDTH

Main pulse width is continuously variable from 0.05 microseconds to 10,000 microseconds in five ranges.

0.05 µsec.	-	1.0 µsec.
1.0 µsec.	-	10 µsec.
10 µsec.	-	100 µsec.
100 µsec.	-	1,000 µsec.
1,000 µsec.	-	10,000 µsec.

NOTE: In the double pulse mode, both output pulses are controlled simultaneously in width.

MAIN PULSE

The following are the specifications of the main output pulse.

AMPLITUDE 50V., minimum, into a 50Ω load

POLARITY Positive or negative, but not simultaneously

RISE TIME 0.015 microseconds

FALL TIME 0.015 microseconds

NOTE: The rise and fall time of the output pulse may be independently degraded to approximately 1 microsecond. In the double pulse mode, rise times degrade simultaneously and fall times degrade simultaneously.

OVERSHOOT AND UNDERSHOOT 5%, maximum, except when pulse is attenuated more than 30db. with the 10db. step attenuator. 30%, maximum, at 50db. down.

DROOP:

0-100 µsec. wide pulse	Negligible.
100-1,000 µsec. wide pulse	15%, maximum.
1,000-10,000 µsec. wide pulse	25%, maximum.

DUTY FACTOR 30%, maximum, at full output amplitude. Automatic limiting circuitry reduces the output amplitude at duty factors greater than 30%. The unit may be safely operated to approximately a 70% duty factor. Output amplitude is approximately 35 volts at 50% duty factor and approximately 20 volts at 70%. In the double pulse mode, duty factor applies to the sum of both pulse widths.

ATTENUATION 0 to 60db., continuously variable.

OUTPUT IMPEDANCE 50Ω.

SYNC PULSE OUT

The following sync. pulse is available at a front panel connector.

AMPLITUDE	10V., minimum.
WIDTH	0.05 μsec., minimum.
RISE TIME	0.03 μsec., maximum.
POLARITY	Positive.

MISCELLANEOUS SPECIFICATIONS

The following are miscellaneous specifications of the instrument.

POWER REQUIRED	115V., 4 amps., 50-60 cps, 375 watts.
VENTILATION	Forced Air.
DIMENSIONS	8 3/4" X 19 1/2" X 13".
WEIGHT, NET	42 lbs.
WEIGHT, SHIPPING	56 lbs.
ACCESSORIES INCLUDED	One instruction manual.

OPERATING INSTRUCTIONS

Refer to Fig. C for the location of all of the front panel controls described below.

FREQUENCY RANGE SWITCH When operated in the internal oscillator positions rotary switch S110 switches timing capacitors C110 through C119 in the grid circuits of V11 to determine the frequency range of the oscillator. In the external trigger position, the switch applies the external trigger pulse to the grid of the Schmitt trigger tube, V12.

FINE FREQUENCY AND TRIGGER SENSITIVITY CONTROL Potentiometer R115 varies the voltage at the grid of V11 to determine the repetition rate of the oscillator on any of the frequency ranges. During periods of external trigger operation this potentiometer becomes the trigger sensitivity control to determine the triggering level.

EXTERNAL TRIGGER POLARITY SWITCH In the two external trigger positions, positive or negative, depending on the polarity of the input signal, the switch selects the positive pulse from the external trigger tube, V10A, and transfers it through S110 to the input of the Schmitt trigger tube, V12.

DELAY RANGE SWITCH Rotary switch S200 switches timing capacitors C200 through C204 in the grid to ground circuit of V20A to determine the range of pulse delay.

FINE DELAY CONTROL Potentiometer R208 varies the cathode to ground resistance of the pulse delay multivibrator, affording continuous delay settings on all delay ranges.

WIDTH RANGE SWITCH Rotary switch S300 switches timing capacitors C300 through C304 in the grid to ground circuit of V30A to determine the range of pulse width.

FINE WIDTH CONTROL Potentiometer R306 varies the cathode to ground resistance of the pulse width multivibrator, affording continuous width settings on all width ranges.

10db. STEP ATTENUATOR Rotary switch S800 controls the amplitude of the output pulse in 10db. steps.

FINE ATTENUATOR CONTROL Potentiometer R531 affords a continuously variable attenuation through each range of the 10db. step attenuator.

POLARITY SWITCH Rotary switch S450 determines the polarity of the output pulse by grounding various levels of the floating power supply and applying its voltages to the output tubes.

SINGLE-DOUBLE PULSE SWITCH Toggle switch S201 permits the operator a choice of single or double pulse output.

RISE TIME CONTROL Potentiometer R403 varies the resistance in the control grid circuit of the output amplifier in a manner that affects only the time constant of the output pulse rise time.

FALL TIME CONTROL Potentiometer R404 varies the resistance in the control grid circuit of the output amplifier in a manner that affects only the time constant of the output pulse fall time.

EXTERNAL TRIGGER IN J100 couples an external trigger through C100 to the control grid of the external trigger amplifier, V10A.

SYNC. PULSE OUT J101 takes the synchronizing pulse from the cathode of the sync. pulse cathode follower, V10B.

PILOT LIGHT Lamp DS500 lights when 115V. AC, 50-60 cps, single phase power is applied to the power transformer, T500.

ON-OFF SWITCH Switch S500 applies power to the primary winding of the power transformer, T500.

FUSE 4 ampere "slo-blo" fuse F500 protects the pulse generator from overloads.

DUTY CYCLE LIMITING INDICATOR Lamp DS530 lights when the 30% duty factor limitation is exceeded. This lamp, when lit, is a warning to the operator that the amplitude of the output pulse is being automatically reduced.

MAIN PULSE OUT Coaxial connector J800 takes the main pulse from the output of the 10db. step attenuator.

PRELIMINARY INSTRUCTIONS

VENTILATION The model B7F pulse generator is cooled by forced air. It is imperative that both ends of the instrument be kept free of obstructions at all times in order to insure adequate air flow.

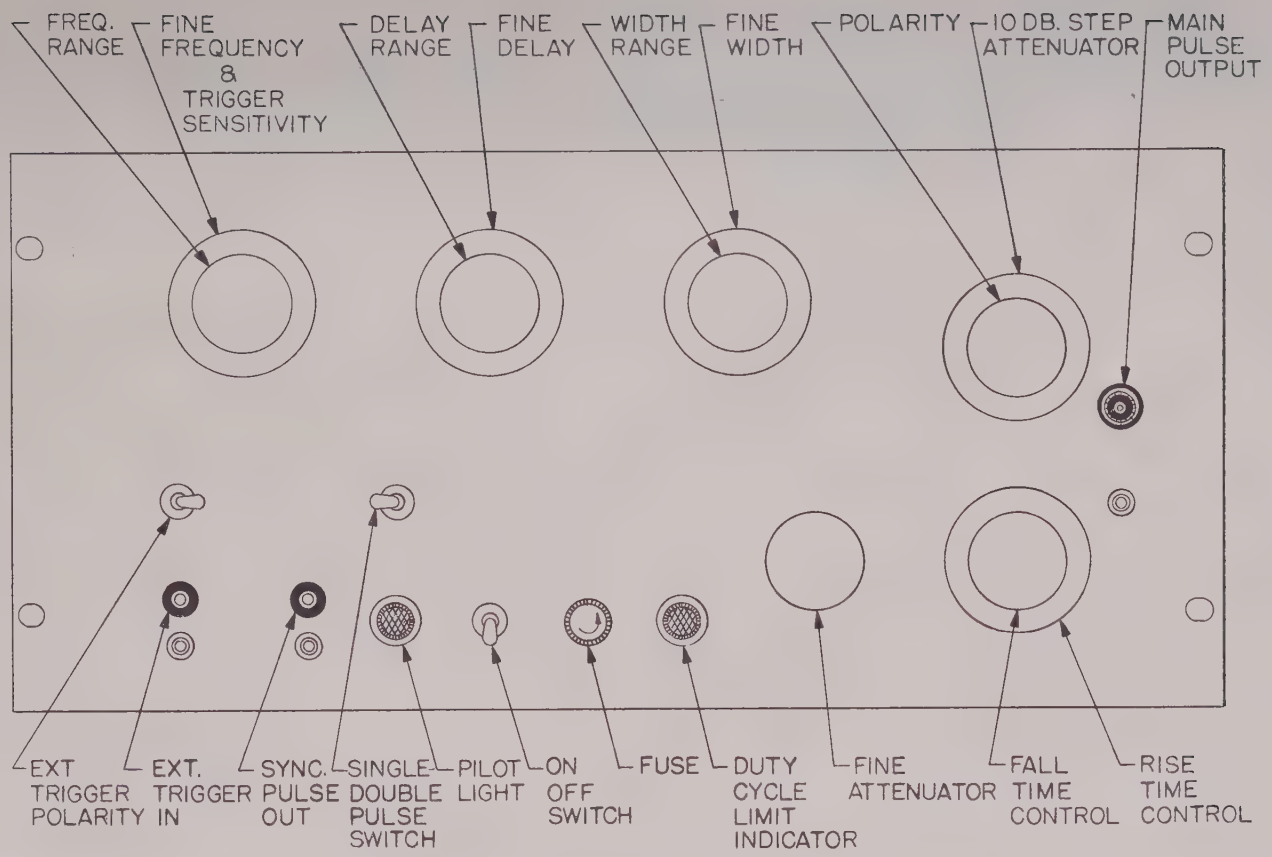


FIG. C FRONT PANEL CONTROLS

It is inadvisable to operate the instrument for appreciable lengths of time with the dust covers removed. These covers not only help to keep the instrument free from dust and other foreign matter, but also properly direct the flow of air through the instrument. Therefore, if the end covers are removed and the instrument mounted in a rack, the dust cover sections must be replaced before rack mounting.

DUTY FACTOR LIMITATION The dissipation limitations of the 6DQ5 power amplifier tubes limit the duty factor of the model B7F pulse generator to 30%, i.e., at full pulse amplitude, the pulse width must never equal greater than 30% of the pulse to pulse spacing. Operation up to approximately 70% duty factor is possible with reduced pulse amplitude.

The 30% duty factor limitation is automatically controlled in the model B7F. Should the duty factor limitation be exceeded, the model B7F automatically reduces the amplitude of the output pulse to such a level that the ratings of the output tubes are not exceeded. When the duty cycle limiter is in operation, the duty cycle lamp on the front panel lights, warning the operator of the reduced pulse amplitude condition.

FIRST TIME OPERATION The following procedure is recommended for putting the instrument into operation for the first time.

1. Turn the power switch to "OFF" and connect the line cord to a source of 115V., 50-60 cps power.

2. Set the instrument controls as follows:

a.	Frequency Range	200 kc
b.	Frequency	100 kc
c.	Delay Range	1 μsec.
d.	Delay	0 μsec.
e.	Width Range	10 μsec.
f.	Width	1 μsec.
g.	10db. Step Attenuator	0 db.
h.	Fine Attenuator	0 db.
i.	Polarity	"+"
j.	Rise Time	Counter-clockwise
k.	Fall Time	Counter-clockwise
l.	Single-Double Pulse Switch	Single Pulse

3. Connect a synchroscope as follows:

a.	Sweep	1 μsec./cm
b.	Vertical Deflection	20 V./cm
c.	Trigger	External from the sync. out connector on the model B7F front panel.

4. Connect a ground strap from one of the model B7F ground binding posts to a ground binding post on the synchroscope.

5. Connect a 50Ω resistive load between the pulse out connector and ground. The output impedance of the model B7F is 50Ω and it is imperative that it be properly terminated if the true output waveform is to be observed.

6. Connect the input probe of the synchroscope across the 50Ω external load. If the true waveform of the output pulse is to be observed, it is imperative that the synchroscope input probe be properly compensated for viewing step function waveforms by adjusting the compensating capacitor in the probe itself and that the probe ground strap be connected to the instrument ground.

7. Turn the model B7F power switch to "ON" and allow approximately one (1) minute for the instrument to reach operating temperature. Adjust the trigger sensitivity of the synchroscope for a stable trace. The model B7F controls may now be set to any desired values within the duty factor limitation.

MAINTENANCE INSTRUCTIONS

DANGER

The power supplies in this instrument operate at voltages which are dangerous to personnel. Extreme caution must be excercised at all times. Repair or maintenance work should never be attempted unless competent personnel, thoroughly trained in the accepted methods of artificial respiration, are in attendance.

DANGER

The following maintenance suggestions are designed to aid the maintenance technician in scheduling regular preventative as well as corrective maintenance routines. It is important that maintenance routines be performed regularly to obtain maximum life and usefullness from the instrument.

FAN MOTOR The fan motor bearings require oil periodically. Use a good grade of light machine oil and apply only a drop or two every six months.

CLEANING THE INSTRUMENT At regular intervals, any dust that has settled on the interior of the instrument should be removed by means of dry compressed air. AVOID high velocity air streams which might injure the instrument or disturb adjustments. Persistent dirt may be removed with a lint-free cloth and, if necessary, carbon tetrachloride.

Under normal conditions, the silver plated contacts of the rotary switches should not require special attention. In case they become tarnished, the contacts should be cleaned by rotating the switch several times.

INSPECTION A visual inspection for loose or broken wiring, loose hardware, and discolored or deformed components is desirable while the instrument is being cleaned.

SWITCHES Turn the rotary switches while observing the contacts to check contact centering in each index position. Improperly centered contacts may be due to the switch becoming warped or twisted. AVOID pressure on the contacts as they are easily damaged.

CAPACITORS AND RESISTORS Inspect the electrolytic capacitors for leakage of electrolyte. Replace if necessary. The wax coating of the paper tubular capacitors may drip if the instrument has been overheated by operation in a restricted space. This condition usually does not indicate replacement.

Composition resistors should be checked for serious discoloration which would indicate excessive dissipation and, therefore, faulty operation. A moderate amount of discoloration is normal.

RACK MOUNTING The model B7F, as purchased, is a portable instrument. It may, however, be mounted in a rack with other instrumentation by removing the louvered end panels. To remove the end panels, first remove both sections of the dust cover. The six sheet metal screws which hold each louvered end panel to the inner end panels are now accessible. Remove these screws and the two screws which hold each end panel to the front panel. Replace both dust covers on the instrument and it is ready for rack mounting. The dust covers must be put back on the instrument before rack mounting as they not only serve to keep dust and other foreign matter out of the instrument, but also help to properly direct the flow of cooling air through the instrument.

CALIBRATION The model B7F contains several controls for the purposes of calibration, pulse shape adjustment, etc. These controls are preset at the factory and should not require readjustment except due to component aging or when electron tubes are replaced.

When readjustment of these controls becomes necessary, the instrument should be allowed to operate for one hour prior to adjustment in order that all components may reach their normal operating temperatures and the instrument has reached maximum stability.

The calibration and checkout chart shown on the following page is patterned after the checkout procedure used at the factory. The chart is intended as a calibration aid only and presupposes that the instrument is in proper working order, except for calibration. It should be noted that there is some interaction between many of the controls. Therefore, it is recommended that the complete calibration and check procedure, working from top to bottom of the chart, be performed at one time on a periodic basis rather than spot adjustments to one circuit which could conceivably have adverse effect on another. Note that an asterisk (*) in any one column indicates that it does not matter which position that control is in for that particular check.

All of the controls used for calibration and adjustment are called out by schematic symbol number on the chassis or circuit board on which they are located, with the following exceptions:

C118 is mounted on the repetition rate switch.

C204 is mounted on the delay switch.

C304 is mounted on the width switch.

R602 is adjustable through the access hole at the rear of the instrument.

TROUBLE SHOOTING It is of extreme importance that the operation, theory, and physical location of components be thoroughly understood before any repair of the instrument is undertaken. A careful study of the circuit descriptions and the schematic diagram will, in most instances, indicate the cause for a particular difficulty in a much shorter time than will a blind point to point check of the entire instrument. It is also suggested that whenever an operational difficulty is encountered, a recheck of the setting and adjustment of the operational controls will often times reveal that a control has been inadvertantly set in the wrong position and that this is the cause of the difficulty.

ELECTRON TUBE FAILURE A major cause of equipment failure is weak or inoperative electron tubes. When a system failure has been traced to a particular circuit, it will be found expedient to test the electron tubes in that circuit, replacing all weak or inoperative ones, before a more detailed examination of the circuit is undertaken. A HICKOCK #539A Tube Checker has been found very satisfactory in detecting electron tubes with low transconductance.

ISOLATION OF THE DEFECTIVE CIRCUIT The following trouble shooting procedure is designed to isolate the trouble to one particular circuit.

Complete failure of the instrument to operate indicates a power source difficulty. Check the source of power and make certain that the power cord plug is firmly in place. Check the fuse on the instrument front panel. A blown fuse indicates an overload condition within the instrument. Blown fuses should not be indiscriminately replaced without first ascertaining the cause of overload, as further damage is likely to result.

TO CHECK OR CALIBRATE		MODEL B7 F DIAL SETTINGS										RISE TIME CONTROL	OSCILLOSCOPE SETTINGS		OBSERVE	ADJUST	REMARKS
		REP. RATE		DELAY		WIDTH		ATTENUATOR		POLARITY			VERTICAL	HORIZONTAL			
		RANGE	VERNIER	RANGE	VERNIER	RANGE	VERNIER	STEP	VERNIER	OUTPUT	TRIGGER						
REP. RATE	20~ 20K 20~-200~ 200 -2KC 2KC-20KC 20KC-200KC — HIGH END	200~-2KC	20	1	1	10	5	*	CW	*	*	CCW	20V/cm	0.1millisec/cm	0.5 millisec Pulse to pulse	R111	There is some interaction between the high and low controls. Therefore, these two adjustments should be readjusted several times until both are correct. Adjustment of this range automatically adjusts the other three ranges.
	LOW END	200~-2KC	2	1	1	10	5			*	*	CCW	20V/cm	1 millisec/cm	5 millisec Pulse to pulse	R116	
	200KC-2MC	200KC-2MC	20	1	MIN	1	MIN	0	CW	*	*	CCW	20V/cm	0.1µsec/cm	0.5µsec Pulse to pulse	C118	This adjustment is to be made only after the four lower ranges have been calibrated.
	EXTERNAL TRIGGER — POSITIVE	EXT. TRIG.	SEE REMARKS	1	MIN	SEE REMARKS			CW	*	+	CCW	20V/cm	SEE REMARKS	One output pulse for each trigger in.	NONE	Use any input trigger from 20~ to 2MC rep. rate, 20V amplitude, and rise time less than 1µsec. Oscilloscope horizontal settings and B7B width setting will depend on rep. rate. Adjust B7B rep. rate vernier for reliable triggering.
	NEGATIVE	EXT. TRIG.	SEE REMARKS	1	MIN	SEE REMARKS		0	CW	*	-	CCW	20V/cm	SEE REMARKS	One output pulse for each trigger in.	NONE	
	SYNC PULSE — AMPLITUDE	200KC-2MC	20	1	MIN		MIN	*	*		*	*	10V/cm	0.1µsec/cm	10V, Minimum	NONE	Looking at pulse at the sync. out jack on the instrument front panel. Polarity of the sync. pulse is positive.
	WIDTH														Approx .05µsec		
	RISE TIME														Approx .03µsec		
PULSE DELAY	1-10 10-100 100-1,000 1,000-10,000	2KC-20KC	18	10	10	1	10	0	CW	*	*	CCW	20V/cm	1µsec/cm	10µsec. - leading edge of sync pulse to leading edge of output pulse.	R200	Adjustment of this range also adjusts the three remaining longer ranges.
	0 to 1		18	1	10	1	MIN	0	CW	*	*	CCW	20V/cm	0.1µsec/cm	1µsec. - leading edge of sync pulse to leading edge of output pulse.	C204	This adjustment is to be made only after the four longer ranges have been calibrated. Note that when the delay vernier is CCW the output pulse occurs coincident with or before the sync. pulse.
PULSE WIDTH	1-10 10-100 100-1,000 1,000-10,000	1KC 20KC-200KC 20K	18	1	MIN	10	10	0	CW	*	*	CCW	20V/cm	1µsec/cm	10µsec. - leading edge to trailing edge of output pulse at 50% amplitude points.	R300	Adjustment of this range also adjusts the three remaining longer ranges.
	0.05 to 1	20KC-200KC	18	1	MIN	1	10	0	CW	*	*	CCW	20V/cm	0.1µsec/cm	1µsec. - leading edge to trailing edge of output pulse at 50% amplitude points.	C304	This adjustment to be made only after the four longer ranges have been calibrated. Note that when the width vernier is CCW the pulse width is 0.05µsec. or less.
OUTPUT PULSE	AMPLITUDE — POS. NEG.	20~-200~	2	1	MIN	10,000	8	0	CW	+	*	CCW	20V/cm	1 millisec/cm	SEE REMARKS	R473 R479	Increase the adjustment until the amplitude of the output pulse near the trailing edge stops increasing and the leading edge starts to peak. Decrease the adjustment until the peaking just disappears.
	PULSE SHAPE — SHORT PULSE	20KC-200KC	18	1	MIN	1	5	0	CW	+	*	CW	20V/cm	0.1µsec/cm	SEE REMARKS	C260 C360 C472	Set C472 for best possible overall pulse shape. Adjust C260 and C360 for improvement. Finally, slight readjustment of all three controls will optimize the pulse shape.
	LONG PULSE	2KC-20KC	18	1	MIN	10	10	0	CW	+	*	CCW	20V/cm	10µsec/cm	SEE REMARKS	C350 R354	Adjust R354 for minimum droop. Adjust C350 for optimum flatness of pulse top. Finally, slight readjustment of both controls will optimize long pulse shape.
	VERNIER — 10db STEP	2KC-20KC	18	1	MIN	10	10	0	CW	+	*	CCW	SEE REMARKS	1µsec/cm	SEE REMARKS	NONE	The step attenuator dial should be rotated to the various dial settings while noting that pulse amplitude decreases accordingly. Change the oscilloscope vertical setting as the attenuator is changed. At high attenuation settings, good grounding between instrument and oscilloscope becomes extremely important.
	ATTENUATOR	2KC-20KC	18	1	MIN	10	10	0	SEE REMARKS	+	*	CCW	20V/cm	1µsec/cm	SEE REMARKS	SEE REMARKS	Turn attenuator vernier CCW until the output pulse decreases 10db. Pulse flatness is pre-adjusted at the factory at this setting with R353. Note, however, that R353 may be adjusted for optimum flatness at any fine attenuator (0 to 10db down) or pulse width setting. Recheck the R354 setting.
	DUTY FACTOR — 200KC-2MC	200KC-2MC	20	1	MIN	1	SEE REMARKS	0	CW	+		CCW	20V/cm	0.1µsec/cm	SEE REMARKS	R602	Set pulse width to 0.16µsec. (this is slightly in excess of 30% duty factor at 2MC). Adjust R602 to the point that pulse amplitude just starts to decrease and the duty cycle lamp on the front panel lights.
	RISE TIME — FASTEST	200KC-2MC	20	1	MIN	1	MIN	0	CW	+	*	CCW	20V/cm	0.02µsec/cm	0.015µsec or less	NONE	Rise and fall times will appear to be greater than 0.015µsec. when viewed on an inferior oscilloscope. The Tektronix type N sampling unit is recommended for direct viewing of actual rise and fall times.
	DEGRADED	2KC-20KC	18			10	5					CW		0.2µsec/cm	Approx 1µsec		
	FALL TIME — FASTEST		20	1	MIN	1	MIN	0	CW	+	*	CCW	20V/cm	0.02µsec/cm	0.015µsec or less	NONE	
	DEGRADED	2KC-20KC	18			10	5					CW		0.2µsec/cm and 5X Magnifier	Approx 1µsec		
DBL. PULSE		200KC-2MC	2	1	5	1	MIN										Delay .5-10,000µsec.

CALIBRATION AND CHECK CHART MODEL B7 F

If power is applied to the instrument but it still fails to operate, a check should be made of the power supply voltages. For this and subsequent checks, it will be necessary to remove the dust covers from the instrument.

It will be necessary to use a synchroscope for further checks. It is important that a synchroscope with a wide band-pass be used as it is impossible to observe many of the fast rise times and narrow pulse widths on an inferior synchroscope. The Tektronix models 517, 541, 543, or 545 have been found satisfactory in observing the waveforms present in the instrument.

If the instrument has no output pulse, check for a sync. pulse at the sync. out jack on the instrument front panel. If there is no sync. pulse, the trouble is in the oscillator section of the instrument. If, however, a sync. pulse is present, synchronize a synchroscope with this pulse and proceed as follows.

Check for a pulse at the input of the attenuator switch, S800. A pulse here isolates the trouble to the switch or its components. If no pulse or a deformed pulse is present, check for a pulse at pins 3 and 6 of V40. If a normal pulse is present at this point, the faulty circuitry is in the output section.

If no pulse is present at the cathodes of V40, the trouble will probably be found in the delay multivibrator or blocking oscillator. If, however, a deformed pulse is present, a study of its shape will be helpful in quickly finding its cause.

If the deformed pulse shows a very slow rise time and normal fall time, the start pulse is missing. Check the start pulse channel. If there are very narrow pulses where the leading and trailing edges of the output pulse would normally be, the clamp circuit is inoperative. If the pulse rises normally and then immediately starts to decay slowly toward zero, the trouble lies in the clamp circuit or the width multivibrator circuit. Finally, if the pulse is normal except for a slow fall time, check the stop pulse channel for faulty operation.

In checking each subsection, it is advisable to start by looking for an output pulse from the section and then work back toward the start of the section. Thus, whenever a normal pulse is found, the trouble is isolated to the stage which immediately follows it.

CIRCUIT DESCRIPTION

OSCILLATOR SECTION The oscillator section consists of the external trigger amplifier, V10A; the free-running multivibrator, V11; the Schmitt trigger, V12; the repetition rate blocking oscillator, V13; and the sync. pulse cathode follower, V10B. V10, V11, V12, and V13 are type 6DJ8 dual triode electron tubes.

The repetition rate of the free-running multivibrator is determined by the action of two front panel controls. The range of the oscillator is determined by the selection of timing capacitors C110 through C119, in the grid circuits of V11, by the oscillator range switch, S110. Fine repetition rate control of the multivibrator, through any range, is determined by varying the fine frequency potentiometer, R115, which varies the voltage to this grid circuit.

The limits of repetition rate for each range are set with the two calibration potentiometers, R111 and R116, which establish the range through which this voltage may vary.

The output, taken from the plate of the multivibrator triggers the Schmitt trigger circuit. The Schmitt trigger circuit shapes the pulse, and sends it to the repetition rate blocking oscillator.

The repetition rate blocking oscillator again shapes the pulse. The basic repetition rate timing pulse is taken from the cathode of this blocking oscillator and is used to trigger the delay multivibrator.

The external trigger amplifier provides a means of triggering the instrument from an external source. The external trigger polarity switch, in either the positive or negative position, depending on the polarity of the input signal, couples the positive pulse from V10A through the repetition rate range switch, S110, to the input grid of the Schmitt trigger. Potentiometer R115 now becomes a trigger sensitivity control to set the triggering level. It should be noted that the repetition rate switch, S110, must be placed in the external trigger position in order to trigger the model B7F from an external source.

The timing pulse taken from the cathode of the repetition rate blocking oscillator is also coupled through a 0.2 μsec. delay line to the grid of the sync. pulse cathode follower. The pulse taken from the cathode is brought to the instrument front panel to be used as a synchronizing pulse for use with other instrumentation. Due to the fact that the sync. pulse occurs approximately 0.2 μsec. after the pulse which triggers the pulse delay circuit, we are able to overcome the inherent delay of the remaining circuitry and can thus produce output pulses which are not delayed in time with respect to the sync. pulse.

DELAY SECTION The delay section consists of the delay multivibrator, V20, and the delay blocking oscillator, V21. V20 is a type 6DJ8 dual triode electron tube and V21 is a type 6DJ8 dual triode electron tube.

In the single pulse mode, the monostable multivibrator, V20, is triggered from its stable state to its quasi-stable state by positive pulses from the oscillator section which are coupled into the grid of V20B and the plate of V20A through diode CR201. The length of time which the multivibrator remains in this quasi-stable state, determined by the timing capacitor

in the grid circuit of V20A and the cathode to ground resistance of V20, is the delay time of the circuit. Thus, this circuit determines the time between the oscillator section timing pulse and the start of the main pulse.

The range of delay is determined by the selection of timing capacitors C200 through C204 by the delay range switch, S200. Fine delay control throughout any range is determined by varying the cathode to ground resistance with the fine delay potentiometer, R208.

R200 sets the voltage to which the grid circuit is returned, thus providing calibration for the various ranges.

A pulse, created by the return of the multivibrator to its stable state after this predetermined delay, is coupled from the plate of V20B to trigger the delay blocking oscillator, V21.

In the double pulse mode, exactly the same action described above takes place. In addition, however, at the same time the delay multivibrator, V20, is being triggered, the delay blocking oscillator, V21, is triggered which creates one output from the blocking oscillator at time zero and a second at a time determined by the delay multivibrator controls.

In either case, the triggers taken from the cathode of the blocking oscillator are the "Start Pulses". These start pulses go to the amplifiers in the start channel and to the width section where they trigger the width multivibrator.

WIDTH SECTION The pulse width section consists of the width multivibrator, V30. V30 is a type 6DJ8 dual triode electron tube.

The monostable multivibrator, V30, is triggered from its stable state to its quasi-stable state by positive pulses from the delay section which are coupled into the grid of V30B and the plate of V30A through diode CR301. The length of time which the multivibrator remains in this quasi-stable state, determined by the timing capacitor in the grid circuit of V30A and the cathode to ground resistance of V30, is the delay time of this circuit. Thus, this circuit determines the time between the delay section output pulse which starts the main pulse and the width section output pulse which stops the main pulse.

The range of pulse width, is determined by the selection of timing capacitors C300 through C304 by the width range switch, S300. Fine width control throughout any range is determined by varying the cathode to ground resistance with the fine width potentiometer, R308.

R300 sets the voltage to which the grid circuit is returned, thus providing calibration for the various ranges.

Two outputs are taken from the width multivibrator. The first is the waveform taken from the plate circuit of V30B. This waveform is a negative-going pulse equal in time duration to the delay time of the width multivibrator. It is coupled through C310 to the grid of the clamp tube, V35B. The second output, a pulse created by the return of the multivibrator to its stable state after the predetermined delay, is known as the "Stop Pulse". This stop pulse is coupled into the amplifiers in the stop channel.

START PULSE CHANNEL The start pulse channel consists of three pulse shaping amplifier stages and the leading edge forming tube. V25 and V26 are type 7119 dual triode electron tubes. V27 is a type 6BQ7A dual triode electron tube.

The start channel receives the positive start pulse from the delay section through a 0.02 microsecond delay line, DL210. This delay line delays the start pulse without delaying the stop pulse, thus allowing a minimum output pulse width of 0.05 microseconds. This pulse goes through three pulse transformer coupled amplifier stages; V25A, V25B, and V26. Pulse transformer T260 couples the amplified pulse into the grids of the leading edge forming tube, V27. This tube drives the output pulse cathode follower, in the pulse forming section, to form the leading edge of the output pulse.

STOP PULSE CHANNEL The stop pulse channel consists of three pulse shaping amplifier stages and the trailing edge forming tube. V35A is ½ of a type 6BQ7A dual triode electron tube. V36 and V37 are type 7119 dual triode electron tubes.

The stop channel receives the positive stop pulse from the width section. It is sent through three stages of transformer coupled amplification; V35A, V36A, and V36B, into the grids of the trailing edge forming tube, V37. This tube drives the output pulse cathode follower, in the pulse forming section, to form the trailing edge of the output pulse.

OUTPUT SECTION The output section consists of the clamp tube, V35B; the pulse forming cathode follower, V40; two power amplifier tubes, V45 and V46; the control grid restoration diode, V47A; and the screen grid disconnect diode, V47B. Electron tube V35B is ½ of a type 6BQ7A dual triode, V40 is a type 7119 dual triode, V45 and V46 are type 6DQ5 power pentodes, and V47 is a type 6DJ8 dual triode.

The clamp tube receives its input from the plate circuit of V30B in the pulse width section. During the period between output pulses, it conducts fully, holding the output at the zero level. Between the start and stop pulses it is completely cut off by the signal from the width multivibrator and holds the output pulse at full amplitude.

The grids of the pulse forming cathode follower are driven positive by the leading edge forming tube, held there by the clamp tube, and driven back to their original level by the trailing edge forming tube. From the cathodes of this tube, we take the fully shaped output pulse. This pulse is coupled through the rise and/or fall time control circuitry to the con-

trol grids of the power amplifiers.

The power amplifiers, connected in parallel, act as a cathode follower for a positive pulse out, and as an inverting amplifier for a negative pulse out. This is accomplished by the action of the polarity switch, S450, which switches the floating power supply voltages to the output power amplifiers as well as coupling the output pulse to the attenuator.

Triode V47A, connected as a diode, provides restoration at the control grids of the output tubes. The restoration level is adjusted by potentiometer R473. V47B, as connected, acts as the screen grid disconnect diode for the output amplifiers.

Finally, the output pulse is sent to the step attenuator, consisting of five 10db. constant impedance T-sections, and to the pulse output jack on the instrument front panel.

POWER SUPPLY SECTION The power supply section contains the power transformer, T500; V50, a type 0A2 voltage regulator tube; V51, a type 6AS7GA dual triode electron tube; V52, a type 12AX7 dual triode electron tube; V53, a type 6U8 triode-pentode electron tube, and their associated circuitry which includes two controls for varying the amplitude of the output pulse.

The power supply section furnishes five unregulated DC voltages (+250V., -4V., -8V., -18V., and -24V.), and three regulated voltages (+150V., -150V., and a positive variable voltage) from its ground reference supplies. From its floating supply it furnishes 150V. above and below a zero reference. It also furnishes filament power for all of the electron tubes in the unit.

The +150V. supply is regulated by the action of V51A and V52A. The -150V. supply is regulated by the action of the voltage regulator tube, V50.

The positive variable voltage, used in two places; as plate supply for the last stage of start pulse amplification and as plate supply for the clamp tube; furnishes a means of varying the amplitude of the output pulse. This supply is regulated by. the action of V51B and V52B. Its reference, however, is set by V53B.

This reference may be varied in two ways. First, it may be varied by varying the fine attenuator, R531. Secondly, it may be varied by the action of the duty cycle limiting control consisting of the circuitry of T600 and V53A.

Transformer T600 senses the ripple voltage in the zero leg of the floating supply. This ripple voltage increases as the output power amplifiers draw more current. The bias on the control grid of V53A is set at such a level by potentiometer R602 that the ripple voltage will take control of the tube at the point where the power amplifiers are drawing rated current and change the reference to lower the variable supply voltage. Thus, the output tubes are never allowed to exceed their dissipation ratings even if the duty factor limitation is inadvertantly exceeded. At the time the variable voltage starts to decrease due to duty cycle limiting, the front panel lamp DS530, lights to warn the operator that the amplitude of the output pulse is being automatically reduced.

CIRCUIT THEORY

This section of the manual contains explanations of several basic circuits which are used in the model B7F. Inasmuch as the technician may not be totally familiar with high repetition rate pulse handling circuitry, it is felt that the inclusion of this section of the manual will lend to a more thorough understanding of the instrument.

FREE-RUNNING MULTIVIBRATOR Fig. D is a simplified circuit of a free-running multivibrator similar to that used in the oscillator section of the model B7F.

Arbitrarily assume that at any specified instant, triode section V1 is conducting fully and triode section V2 is non-conducting because the potential at its control grid is below the cut-off potential of the tube. At this instant, the plate voltage of V1 is lowered due to the current flow through V1 and R1. C2 discharges to this voltage, holding V2 cut off.

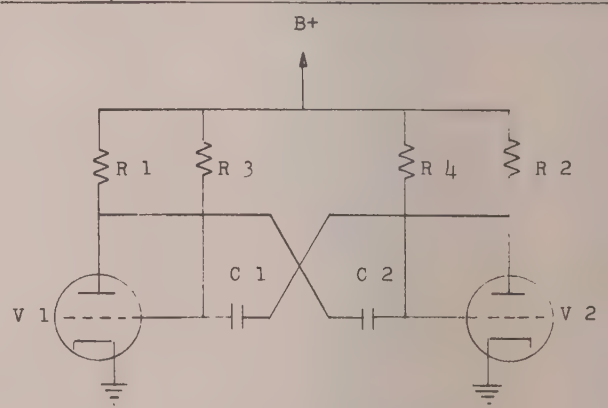


Fig.D FREE-RUNNING MULTIVIBRATOR

After a time determined by the discharge time of C2 through R4, the voltage potential on the grid of V2 reaches the cut-in potential of the tube. V2 starts to conduct and its plate potential drops. This drop is immediately felt at the grid of V1 across C1, driving it to cut-off. Its plate potential rises sharply and capacitor C2 charges to the new voltage, further aiding in the conduction of V2. After the initial change, V2 steadies to a low plate voltage and C1 discharges to the cut-in potential of V1 and the cycle starts over again.

In summary, the operation of this circuit consists of periods of time when one tube conducts a high current while the other tube is cut off, followed by an extremely rapid change to the other tube conducting and the first tube cut off.

The repetition rate of the circuit is determined by the time constants of C1-R3 and C2-R4 and the voltage to which they are returned.

In the model B7F the range of the repetition rate of the oscillator is changed by changing the values of C1 and C2 in decade steps and the repetition rate is made continuously variable for each range by varying the level of the grid return voltage.

MONOSTABLE MULTIVIBRATOR Fig. E shows a simplified circuit of a monostable multivibrator similar to those used in the pulse delay and pulse width sections of the model B7F.

The multivibrator has one stable state and one quasi-stable state. That is, one tube section is capable of remaining in the conducting state indefinitely while the other does not have this capability. In this type of multivibrator it is necessary to trigger the circuit from its stable state to its quasi-stable state with trigger pulses from an external source. Then, the circuit will automatically return to its steble state after a certain length of time. Therefore, in operation, one triode section is triggered from non-conduction to conduction with an applied trigger. It remains in this condition for a predetermined length of time and then returns abruptly to the non-conducting state to await another trigger. Thus, we are able to generate a pulse, at a predetermined time after a given input pulse, by abruptly changing a tube section from conduction to non-conduction. Or, essentially, we have introduced a delay into the system.

Assume that the circuit is in its stable state. V1 is conducting, its grid clamped to its cathode. If R2 is made quite large, the full conduction current through V1 and thus through R6 is small and the grid is clamped near zero potential. The plate of V1, however, is at quite a low potential due to the current through the large R2. V2 is not conducting, its grid held below cut-off by the divider formed by R3, R4, and R7 between the low positive plate potential of V1 and -150 volts.

Now, at some time, a positive timing pulse arrives at the junction of the C2-R3, C3-R4 combination through diode CR1. This pulse is felt sharply across C2 and C3 at the plate of V1 and the grid of V2. V1 starts to cut off. V2 starts conducting. If R5 is small compared to R2, V2 will conduct much more heavily than V1 was conducting. The drop across R6 becomes greater due to this higher current through V2, thus the cathodes raise to a higher potential. This holds V1 off completely. The plate of V1, now at a higher potential, keeps the grid of V2 above its cut-off potential by the same divider network mentioned above. Thus, in a very short time, a trigger pulse has changed the state of the multivibrator from that of V1 conducting a small amount and V2 cut off, to one of V1 cut off and V2 conducting quite heavily.

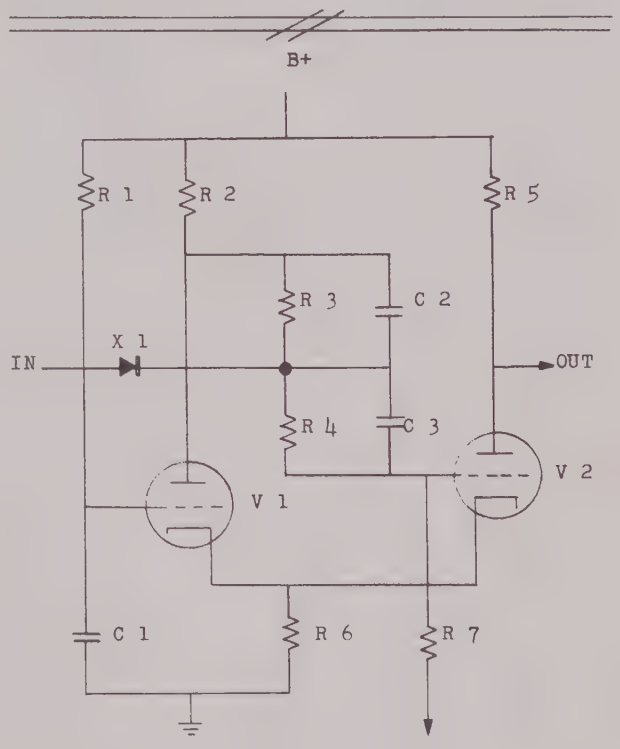


Fig. E MONOSTABLE MULTIVIBRATOR

As soon as V1 is cut off by raising its cathode potential several volts with respect to its grid potential, C1 starts to charge through R1 toward the B+ potential. After a time, predetermined by the R1-C1 combination, the grid of V1 will reach cut-in potential and V1 will again start to conduct. The plate of V1 drops. This drop is felt at the grid of V2 through C2 and C3, immediately cutting off V2. The drop which cuts V2 off also drops the cathode potentials, which aids the conduction of V1. C1 discharges rapidly through the low grid to cathode resistance of V1, and the circuit has returned to its original stable state. At the transition point of V2 conducting to non-conducting, the plate waveform of V2 goes sharply positive. This waveform is taken as the output. Thus, we have produced a pulse, delayed from the original trigger pulse, by a time predetermined by R1-C1.

In the model B7F the range of delay of the pulse delay and pulse width multivibrators is changed by changing the value of C1 in decade steps. Delay and width are made continuously variable through any range by varying R6, which varies the cathode potential in the quasi-stable state, thus determining the potential which the grid must reach to cut V1 on and return the multivibrator to its stable state.

BLOCKING OSCILLATOR Fig. F shows a typical blocking oscillator circuit such as is used in the model B7F oscillator and pulse delay sections.

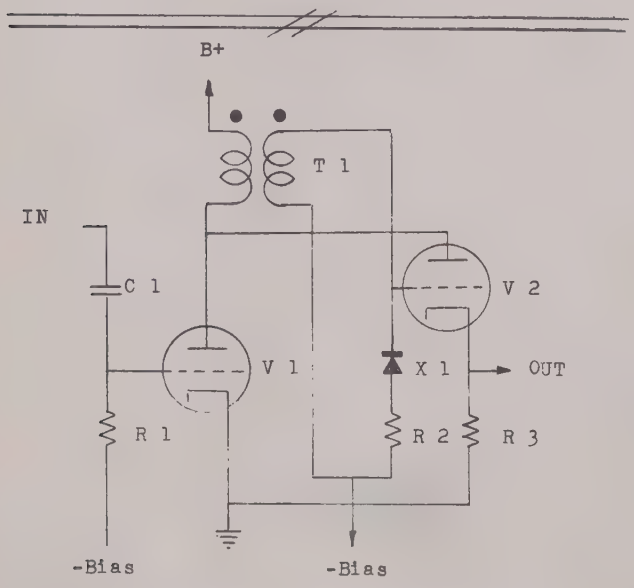


Fig. F MONOSTABLE BLOCKING OSCILLATOR

This blocking oscillator is a so-called monostable or driven type. That is, it is not free-running, but requires a trigger from an external source to excite it. It produces a high powered, extremely sharp, narrow pulse which is essentially independent of the shape or degradation of the pulse which triggers it.

V1 serves to amplify the input trigger and to eliminate the possibility of a reaction by the blocking oscillator back on the trigger pulse source.

In the quiescent condition, both sections of the tube are biased below cut-off. A positive trigger is coupled through C1 to the amplifier tube, V1, which inverts and amplifies it. Pulse transformer T1 inverts and applies this waveform to the grid of V2, the blocking oscillator tube. V2 conducts causing a drop in its plate voltage. The drop in plate voltage in turn causes an increase in grid voltage, which results in a further decrease in plate voltage. Due to the AC loop gain of the circuit being greater than unity, regeneration occurs. The plate drives abruptly downward and the grid abruptly upward. This action continues until such time as the loop gain drops below unity, due to the nonlinearity of the tube.

The plate and grid cannot remain at the values attained by the regenerative action described above because of the low frequency characteristics of the transformer. The grid starts to drop due to its finite magnetizing inductance. When the grid voltage has dropped far enough that the loop gain once again equals unity, a regenerative action once again occurs in the direction to turn the tube off.

An overshoot occurs at the plate and grid of the tube. At the conclusion of the pulse there is still a current flowing in the magnetizing inductance of the transformer. Since this current cannot change instantaneously, it continues to flow through the effective capacitance of the transformer after the tube current has dropped to zero, causing this overshoot.

The pulse width and rise time are dependent almost entirely on the design of the transformer. The pulse transformers used in the model B7F blocking oscillators are specifically designed to produce extremely narrow, fast rise time pulses.

In the oscillator and pulse width sections of the model B7F, blocking oscillators such as described above are used. In both of these cases, a positive pulse is taken from the cathode as the output pulse.

SCHMITT TRIGGER Fig. G shows a typical Schmitt trigger circuit such as is used in the model B7F oscillator section.

The Schmitt trigger is a monostable circuit, that is, it is not free-running, but requires a trigger from an external source to excite it.

This circuit produces an extremely sharp pulse which is essentially independent of the amplitude and waveform of the pulse which triggers it.

In the quiescent condition, V2 is conducting, V1 is not conducting, its grid held below cut-off by the divider network formed by R4 and R5 between the cathodes of V1 and V2 and ground. A positive trigger is coupled through C1 to the grid of V1, causing the tube to conduct. For an instant, the voltage across the cathode resistors increases, driving the grid of V2 towards cut-off. This, in addition to the drop in plate voltage of V1, causes a rapid change in V2 from conducting to a cut off condition. V2 will remain cut off until the input signal has decreased to the cut-off value of V1. As soon as V1 is cut off by the changing input signal, the plate voltage of V1 will rise, causing the voltage on the grid of V2 to rise, and V2 conducts.

Thus, in a short time the circuit has been triggered between its two stable states by a trigger pulse whose amplitude exceeds a definite positive value and changes to a definite less positive value.

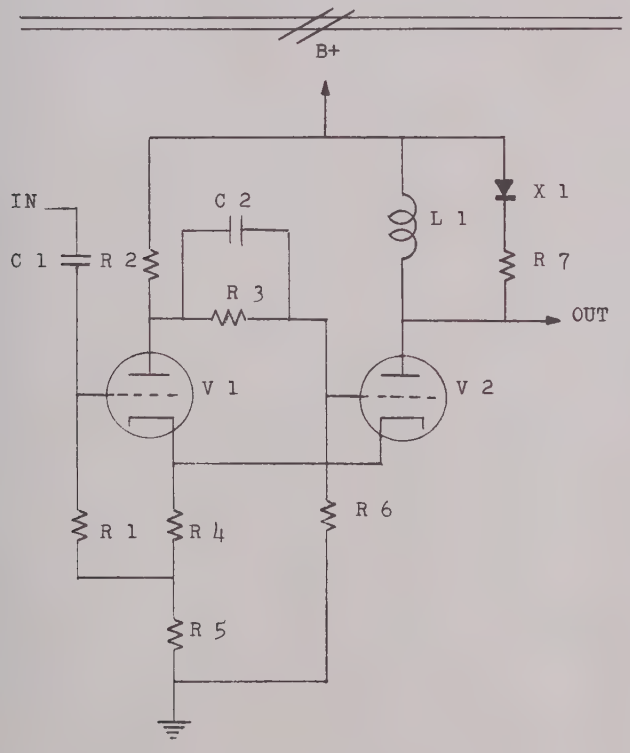


Fig. G SCHMITT TRIGGER

PARTS LIST

ABBREVIATIONS

cer	ceramic	m	milli or 10^3	PT	paper tubular
comp	composition	Meg	megohm or 10^6 ohms	SET	solid electrolytic tantalum
EMC	electrolytic, metal cased	MF	metal film	SM	silvered mica
EMT	electrolytic, metal tubular	μ	micro or 10^6	V	working volts, DC
f	farad	μμ	micro or 10^{12}	var	variable
GMV	guaranteed minimum value	Ω	ohm	W	watt
h	henry	prec	precision	WW	wire wound
k	kilohm or 10^3 ohms				

CAPACITORS

C100	.01 μf	fixed	cer	500V	GMV
C101	.01 μf	fixed	cer	500V	GMV
C102	.01 μf	fixed	cer	500V	GMV
C103	.01 μf	fixed	cer	500V	GMV
C104	.01 μf	fixed	cer	500V	GMV
C105	.01 μf	fixed	cer	500V	GMV
C108	4.7 μf	fixed	mylar	150V	±1%
C109	4.7 μf	fixed	mylar	150V	±1%
C110	.47 μf	fixed	mylar	150V	±1%
C111	.47 μf	fixed	mylar	150V	±1%
C112	.047 μf	fixed	mylar	150V	±1%
C113	.047 μf	fixed	mylar	150V	±1%
C114	4700μμf	fixed	SM	500V	±1%
C115	4700μμf	fixed	SM	500V	±1%
C116	470μμf	fixed	SM	500V	±1%
C117	470μμf	fixed	SM	500V	±1%
C118	5-80μμf	var	mica	175V	
C119	47μμf	fixed	SM	500V	±5%
C120	100μμf	fixed	cer	500V	±10%
C121	5μμf	fixed	SM	500V	±5%
C122	.01 μf	fixed	cer	500V	GMV
C123	.01 μf	fixed	cer	500V	GMV
C130	200μμf	fixed	cer	500V	±10%
C131	.01 μf	fixed	cer	500V	GMV
C132	.01 μf	fixed	cer	500V	GMV
C200	.47 μf	fixed	mylar	150V	±1%
C201	.047 μf	fixed	mylar	150V	±1%
C202	4700μμf	fixed	SM	500V	±1%
C203	470μμf	fixed	SM	500V	±1%
C204	5-80μμf	var	mica	175V	
C205	.01 μf	fixed	cer	500V	GMV
C206	100μμf	fixed	SM	500V	±5%
C207	100μμf	fixed	SM	500V	±5%
C208	.001 μf	fixed	cer	500V	±10%
C209	.01 μf	fixed	cer	500V	GMV
C210	100μμf	fixed	cer	500V	±10%
C211	.01 μf	fixed	cer	500V	GMV
C212	.01 μf	fixed	cer	500V	GMV
C213	.01 μf	fixed	cer	500V	GMV
C215	100μμf	fixed	cer	500V	±10%
C250	.01 μf	fixed	cer	500V	GMV
C260	1.5-7μμf	var	cer	500V	
C261	.01 μf	fixed	cer	500V	GMV

C300	.47 µf	fixed	mylar	150V	±1%
C301	.047 µf	fixed	mylar	150V	±1%
C302	4700µµf	fixed	SM	500V	±1%
C303	470µµf	fixed	SM	500V	±1%
C304	5-80µµf	var	mica	175V	
C306	100µµf	fixed	SM	500V	±5%
C307	100µµf	fixed	SM	500V	±5%
C308	100µµf	fixed	cer	500V	±10%
C309	2 µf	fixed	EMT	450V	-10+50%
C310	.25 µf	fixed	MP	200V	±20%
C311	.01 µf	fixed	cer	500V	GMV
C350	4-30µµf	var	cer	500V	
C351	.01 µf	fixed	cer	500V	GMV
C352	.01 µf	fixed	cer	500V	GMV
C360	4-30µµf	var	cer	500V	
C361	.01 µf	fixed	cer	500V	GMV
C362	.01 µf	fixed	cer	500V	GMV
C363	.01 µf	fixed	cer	500V	GMV
C400	.5 µf	fixed	MP	600V	±20%
C401	.01 µf	fixed	cer	500V	GMV
C404	.03 µf	fixed	cer	500V	GMV
C405	2 µf	fixed	EMT	450V	-10+50%
C450	20 µf	fixed	EMT	350V	-10+50%
C451	.01 µf	fixed	cer	500V	GMV
C452	33µµf	fixed	SM	500V	±5%
C453	22µµf	fixed	SM	500V	±5%
C460	20 µf	fixed	EMT	350V	-10+50%
C461	.01 µf	fixed	cer	500V	GMV
C462	33µµf	fixed	SM	500V	±5%
C470	.25 µf	fixed	MP	200V	±20%
C471	.01 µf	fixed	cer	500V	GMV
C472	9-180µµf	var	mica	175V	
C473	.01 µf	fixed	cer	500V	GMV
C474	.25 µf	fixed	MP	200V	±20%
C500	80-80 µf	fixed	EMC	350V	-10+50%
C501	80-80 µf	fixed	EMC	350V	-10+50%
C502	80-80 µf	fixed	EMC	350V	-10+50%
C503	.1 µf	fixed	PT	400V	±20%
C520	.1 µf	fixed	PT	400V	±20%
C521	2 µf	fixed	EMT	450V	-10+50%
C522	.1 µf	fixed	PT	400V	±20%
C523	2 µf	fixed	EMT	450V	-10+50%
C530	.1 µf	fixed	PT	400V	±20%
C531	.1 µf	fixed	PT	400V	±20%
C600	50 µf	fixed	EMT	25V	-10+100%
C601	200-200 µf	fixed	EMC	250V	-10+50%
C602	200-200 µf	fixed	EMC	250V	-10+50%
C603	200-200 µf	fixed	EMC	250V	-10+50%
C604	200-200 µf	fixed	EMC	250V	-10+50%
C700	1500 µf	fixed	EMC	50V	-10+50%
C801	2 µf	fixed	MP	200V	±20%
C804	2 µf	fixed	MP	200V	±20%
C805	22µµf	fixed	cer	1KV	±20%

CHOKES

L120	75 µH	fixed	±10%
L200	25 µH	fixed	±10%
L300	25 µH	fixed	±10%

CONNECTORS

J100	Nylon Binding Post
J101	Nylon Binding Post
J800	Type SO-239

DELAY LINES

DL100	.2 µsec.	fixed
DL210	.02 µsec.	fixed
DL211	.15 µsec.	fixed

DIODES

CR120	Type 1N116
CR130	Type 1N34A
CR200	Type 1N34A
CR201	Type 1N116
CR203	Type 1N116
CR204	Type 1N116
CR210	Type 1N34A
CR250	Type 1N774
CR251	Type 1N774
CR300	Type 1N34A
CR301	Type 1N116
CR350	Type 1N774
CR360	Type 1N774
CR361	Type 1N774
CR400	Type 1N98
CR401	Type 1N98
CR402	Type 1N98

CR403			Type 1N98
CR404			Type 1N98
CR405			Type 1N98
CR500	Rectifier, Silicon	200ma	360PIV
CR501	Rectifier, Silicon	200ma	360PIV
CR502	Rectifier, Silicon	200ma	360PIV
CR503	Rectifier, Silicon	200ma	360PIV
CR504	Rectifier, Silicon	200ma	360PIV
CR505	Rectifier, Silicon	200ma	360PIV
CR530	Rectifier, Silicon	200ma	360PIV
CR600	Rectifier, Silicon	500ma	400PIV
CR601	Rectifier, Silicon	500ma	400PIV
CR602	Rectifier, Silicon	500ma	400PIV
CR603	Rectifier, Silicon	500ma	400PIV
CR604	Rectifier, Silicon	200ma	360PIV
CR700	Rectifier, Silicon	200ma	360PIV
CR701	Rectifier, Silicon	200ma	360PIV

ELECTRON TUBES

V10	Type 6DJ8
V11	Type 6DJ8
V12	Type 6DJ8
V13	Type 6DJ8
V20	Type 6DJ8
V21	Type 6DJ8
V25	Type 7119
V26	Type 7119
V27	Type 6BQ7A
V30	Type 6DJ8
V35	Type 6BQ7A
V36	Type 7119
V37	Type 7119
V40	Type 7119
V45	Type 6DQ5
V46	Type 6DQ5
V47	Type 6DJ8
V50	Type 0A2
V51	Type 6AS7GA
V52	Type 12AX7
V53	Type 6U8

FUSES

F500	4 amperes	Slo-blo

LAMPS

I500	#47
I530	NE51

RESISTORS

R100	150k	fixed	comp	½W	±10%
R101	1k	fixed	comp	½W	±10%
R102	10k	fixed	comp	½W	±10%
R103	1k	fixed	comp	½W	±10%
R104	1k	fixed	comp	½W	±10%
R105	680Ω	fixed	comp	½W	±10%
R110	1k	fixed	comp	1W	±10%
R111	10k	var	comp	2W	±20%
R112	1k	fixed	comp	1W	±10%
R113	75k	fixed	comp	½W	± 5%
R114	75k	fixed	comp	½W	± 5%
R115	10k	var	comp	2W	±20%
R116	5k	var	comp	1W	±20%
R117	4.7k	fixed	comp	2W	±10%
R120	6.8k	fixed	comp	½W	±10%
R121	470Ω	fixed	comp	½W	±10%
R122	150k	fixed	comp	½W	±10%
R123	1meg	fixed	comp	½W	±10%
R124	1.2k	fixed	comp	½W	±10%
R125	6.8k	fixed	comp	½W	±10%
R126	68k	fixed	comp	½W	±10%
R127	39k	fixed	comp	½W	±10%
R128	3.3meg	fixed	comp	½W	±10%
R130	470Ω	fixed	comp	½W	±10%
R131	1k	fixed	comp	1W	±10%
R132	1k	fixed	comp	½W	±10%
R200	100k	var	comp	1W	±20%
R201	100k	fixed	comp	½W	±10%
R202	47Ω	fixed	comp	½W	±10%
R203	470Ω	fixed	comp	½W	±10%
R204	100k	fixed	prec	½W	± 1%
R205	27k	fixed	comp	½W	±10%
R206	12k	fixed	comp	2W	±10%
R207	220Ω	fixed	comp	2W	±10%
R208	500Ω	var	comp	2W	±20%
R209	300k	fixed	comp	½W	± 5%
R210	470Ω	fixed	comp	½W	±10%
R211	3.3k	fixed	comp	½W	±10%
R212	470Ω	fixed	comp	2W	±10%
R213	1k	fixed	comp	½W	±10%
R214	1k	fixed	comp	½W	±10%
R215	3.3k	fixed	comp	½W	±10%
R250	1k	fixed	comp	½W	±10%
R251	150Ω	fixed	comp	½W	±10%
R252	330Ω	fixed	comp	½W	±10%
R260	1k	fixed	comp	2W	±10%
R261	1k	fixed	comp	2W	±10%
R300	100k	var	comp	1W	±20%
R301	100k	fixed	comp	½W	±10%
R302	47Ω	fixed	comp	½W	±10%

R303	470Ω	fixed	comp	½W	±10%
R304	100k	fixed	prec	⅛W	± 1%
R305	27k	fixed	comp	⅛W	±10%
R306	12k	fixed	comp	⅛W	±10%
R307	470Ω	fixed	comp	2W	±10%
R308	500Ω	var	comp	2W	±20%
R309	300k	fixed	comp	½W	± 5%
R350	470k	fixed	comp	½W	±10%
R351	3.3k	fixed	comp	⅛W	±10%
R352	330Ω	fixed	comp	⅛W	±10%
R353	250k	var	comp	2W	±30%
R354	50k	var	comp	2W	±30%
R355	150k	fixed	comp	½W	±10%
R356	68k	fixed	comp	2W	±10%
R357	10k	fixed	comp	½W	±10%
R360	330Ω	fixed	comp	⅛W	±10%
R361	330Ω	fixed	comp	⅛W	±10%
R400	22k	fixed	comp	2W	±10%
R401	47Ω	fixed	comp	½W	±10%
R402	3.3k	fixed	comp	2W	±10%
R403	10k	var	comp	2W	±30%
R404	25k	var	comp	2W	±30%
R450	10Ω	fixed	comp	2W	±10%
R452	47Ω	fixed	comp	⅛W	±10%
R453	100Ω	fixed	comp	⅛W	±10%
R460	10Ω	fixed	comp	2W	±10%
R462	47Ω	fixed	comp	½W	±10%
R470	1meg	fixed	comp	½W	±10%
R471	1.5k	fixed	comp	⅛W	±10%
R472	4.7k	fixed	comp	2W	±10%
R473	5k	var	comp	2W	±30%
R474	3.3k	fixed	comp	2W	±10%
R475	100Ω	fixed	comp	½W	±10%
R500	100k	fixed	comp	½W	±10%
R501	3k	fixed	WW	10W	±10%
R502	150k	fixed	comp	1W	±10%
R510	10Ω	fixed	comp	⅛W	±10%
R511	73.2k	fixed	prec	⅛W	± 1%
R512	68.1k	fixed	prec	⅛W	± 1%
R513	10Ω	fixed	comp	⅛W	±10%
R514	220k	fixed	comp	⅛W	± 5%
R515	150k	fixed	comp	⅛W	± 5%
R516	1.5k	fixed	WW	25W	±10%
R520	220k	fixed	comp	⅛W	±10%
R521	470k	fixed	comp	⅛W	±10%
R522	22k	fixed	comp	2W	±10%
R530	270k	fixed	comp	⅛W	± 5%
R531	250k	var	comp	2W	±20%
R532	680k	fixed	comp	½W	±10%
R533	120k	fixed	comp	⅛W	±10%
R534	100k	fixed	comp	⅛W	±10%
R535	6.8k	fixed	comp	2W	±10%
R536	6.8k	fixed	comp	2W	±10%
R600	.75Ω	fixed	WW	5W	± 5%
R601	3.3meg	fixed	comp	⅛W	±10%
R602	50k	var	comp	1W	±30%
R603	15k	fixed	comp	½W	±10%
R604	100k	fixed	comp	⅛W	±10%
R605	100k	fixed	comp	⅛W	±10%
R700	47Ω	fixed	comp	2W	± 5%
R701	160Ω	fixed	comp	2W	± 5%
R702	33Ω	fixed	comp	1W	± 5%
R703	33Ω	fixed	comp	1W	± 5%
R704	33Ω	fixed	comp	1W	± 5%
R705	160Ω	fixed	comp	2W	± 5%
R800	270Ω	fixed	MF	8W	± 5%
R801	270Ω	fixed	MF	8W	± 5%
R802	270Ω	fixed	MF	8W	± 5%
R803	75Ω	fixed	MF	6W	± 5%
R804	75Ω	fixed	MF	6W	± 5%
R805	75Ω	fixed	MF	6W	± 5%
R806	82k	fixed	comp	⅛W	±10%
R807	82k	fixed	comp	⅛W	±10%
R810	2ea 52Ω	fixed	MF		± 5%
R811	26Ω	fixed	MF	W	± 5%
R812	2ea 70Ω	fixed	MF	6W	± 5%
R820	26Ω	fixed	MF	4W	± 5%
R821	26Ω	fixed	MF	4W	± 5%
R822	35Ω	fixed	MF	4W	± 5%
R830	27Ω	fixed	comp	⅛W	± 5%
R831	27Ω	fixed	comp	⅛W	± 5%
R832	36Ω	fixed	comp	⅛W	± 5%
R840	27Ω	fixed	comp	⅛W	± 5%
R841	27Ω	fixed	comp	⅛W	± 5%
R842	36Ω	fixed	comp	⅛W	± 5%
R850	27Ω	fixed	comp	⅛W	± 5%
R851	27Ω	fixed	comp	⅛W	± 5%
R852	36Ω	fixed	comp	⅛W	± 5%

SWITCHES

S100	SPDT	Ext. Trig. Pol. Toggle
S110	B7F-B-501	RUTHERFORD
S200	B7B-B-520	RUTHERFORD
S201	SPST	Single-Double Pulse Toggle
S300	B7B-B-520	RUTHERFORD
S450	B7B-B-522	RUTHERFORD
S500	SPST	"On-Off" Toggle
S800	B7B-B-521	RUTHERFORD

THERMISTOR

RT500	0.5-4Ω	25W

TRANSFORMERS

T130	B7-501	RUTHERFORD

T210	B7-501	RUTHERFORD
T250	B7-502	RUTHERFORD
T251	B7-504	RUTHERFORD
T260	B7-504	RUTHERFORD
T350	B7-502	RUTHERFORD
T360	B7-502	RUTHERFORD
T361	B7-504	RUTHERFORD
T500	B7-D-500	RUTHERFORD
T600	#45753	TRIAD

FERRITE BEAD

FB400	56-590-65/3B	FERROXCUBE
FB450	56-590-65/3B	FERROXCUBE
FB460	56-590-65/3B	FERROXCUBE

REPLACEMENT OF COMPONENTS

In the event that component replacement becomes necessary, it is strongly recommended, in order to avoid considerable delay and unnecessary expense, that such replacement components be purchased from your local electronics supplier. A large majority of the components used in the instrument are standard electronic components and little difficulty should be encountered in replacing them.

Certain components, manufactured to RUTHERFORD ELECTRONICS CO'S specifications, may not be readily available through local suppliers. These components should be ordered from our factory.

MANUAL AND REPAIR PARTS When ordering a manual please indicate the instrument model number and its serial number and date of original purchase. For spare parts, we suggest, 1) a careful description of the part, and 2) the model number and serial number of the instrument and date of original purchase. If possible, please identify parts in relation to the schematic, giving data shown on the circuit schematic diagram.

WARRANTY

RUTHERFORD ELECTRONICS CO. guarantees to the original purchaser for a period of one (1) year, EXCEPT electron tubes which are guaranteed for ninety days, that this instrument is free from defects in material and workmanship. Our liability is limited to repair or replacement of this instrument, or any part thereof, providing failure is not due to misuse or abnormal conditions.

In order to receive service under this warranty, promptly advise the factory of all details pertinent to failure of the instrument. Replacement parts will be shipped via air transportation if requested, prepaid to any point in the continental United States. Should it be desirable to return the instrument, ship it prepaid to the factory, and it will be serviced as required and returned via surface transportation, prepaid.

The RUTHERFORD ELECTRONICS CO. reserves the right not to honor warranty on any instrument with modifications done by the user. Before modifying, it is suggested that the modification be forwarded to the RUTHERFORD ELECTRONICS CO. for their approval, if it is desired to keep the instrument in its remaining warranty period. Send a schematic of the circuit under modification and an explanation of what will be done. In return, the RUTHERFORD ELECTRONICS CO. will evaluate your proposal and inform you as to its warranty position.

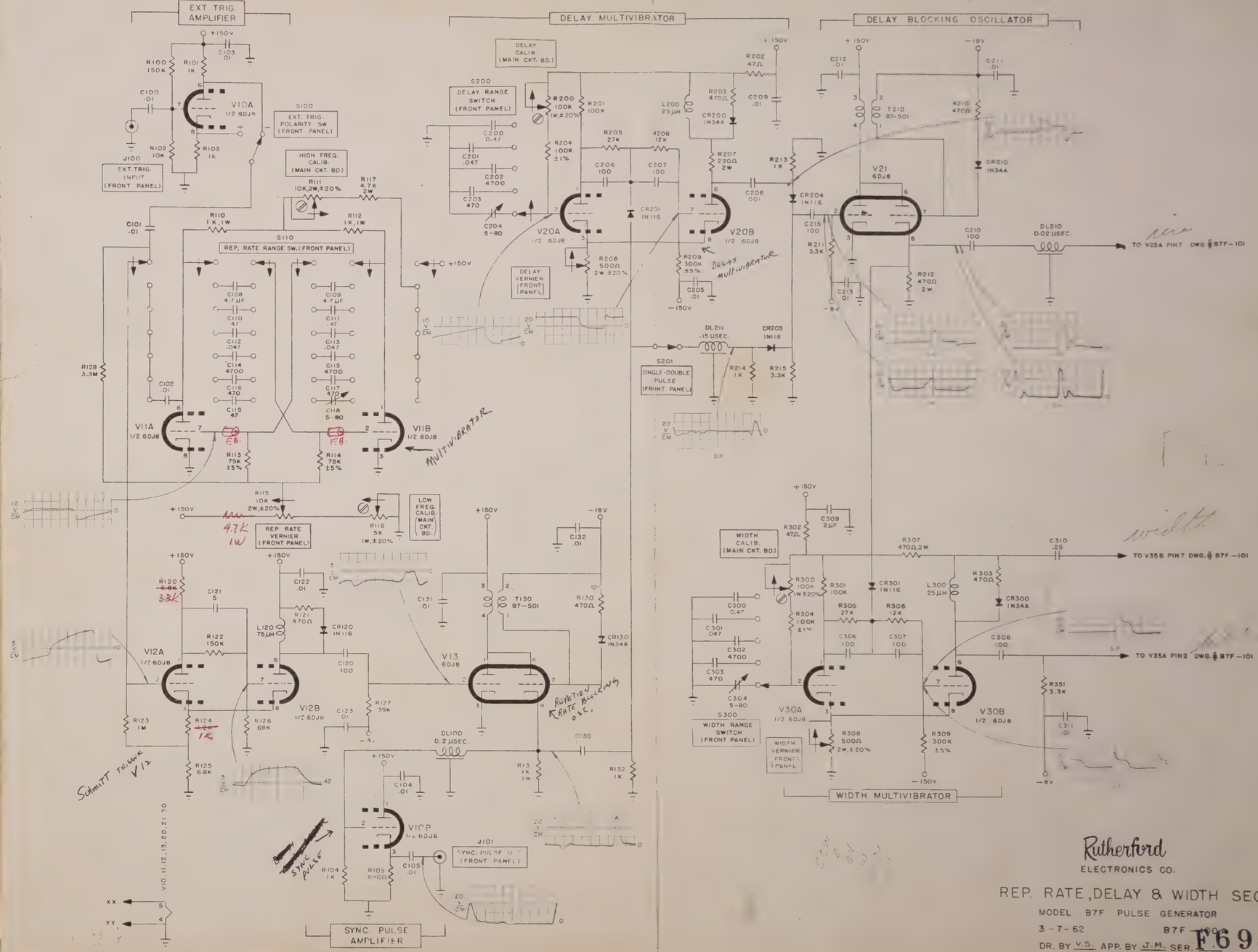
Service required after the expiration of warranty, or because of misuse or abnormal conditions will be billed at cost.

NOTES: UNLESS OTHERWISE SPECIFIED,

1. ALL FIXED RESISTORS ARE 1/2 WATT ±10%
2. ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS, THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS.

WAVEFORMS

PULSE GENERATOR SETTING:	REP. RATE	1 MC
	DELAY	0.5 μSEC.
	WIDTH	0.1 μSEC
OSCILLOSCOPE SETTING:	TIME/CM	0.1 μSEC
(TEKTRONIX TYPE 541A)	VOLTS/CM	AS SPECIFIED



A	7-27-62	C130 200 μμf to 100 μμf	V.S.	JM
ITR	DATE	CHANGE	BY	APP

Rutherford
ELECTRONICS CO.

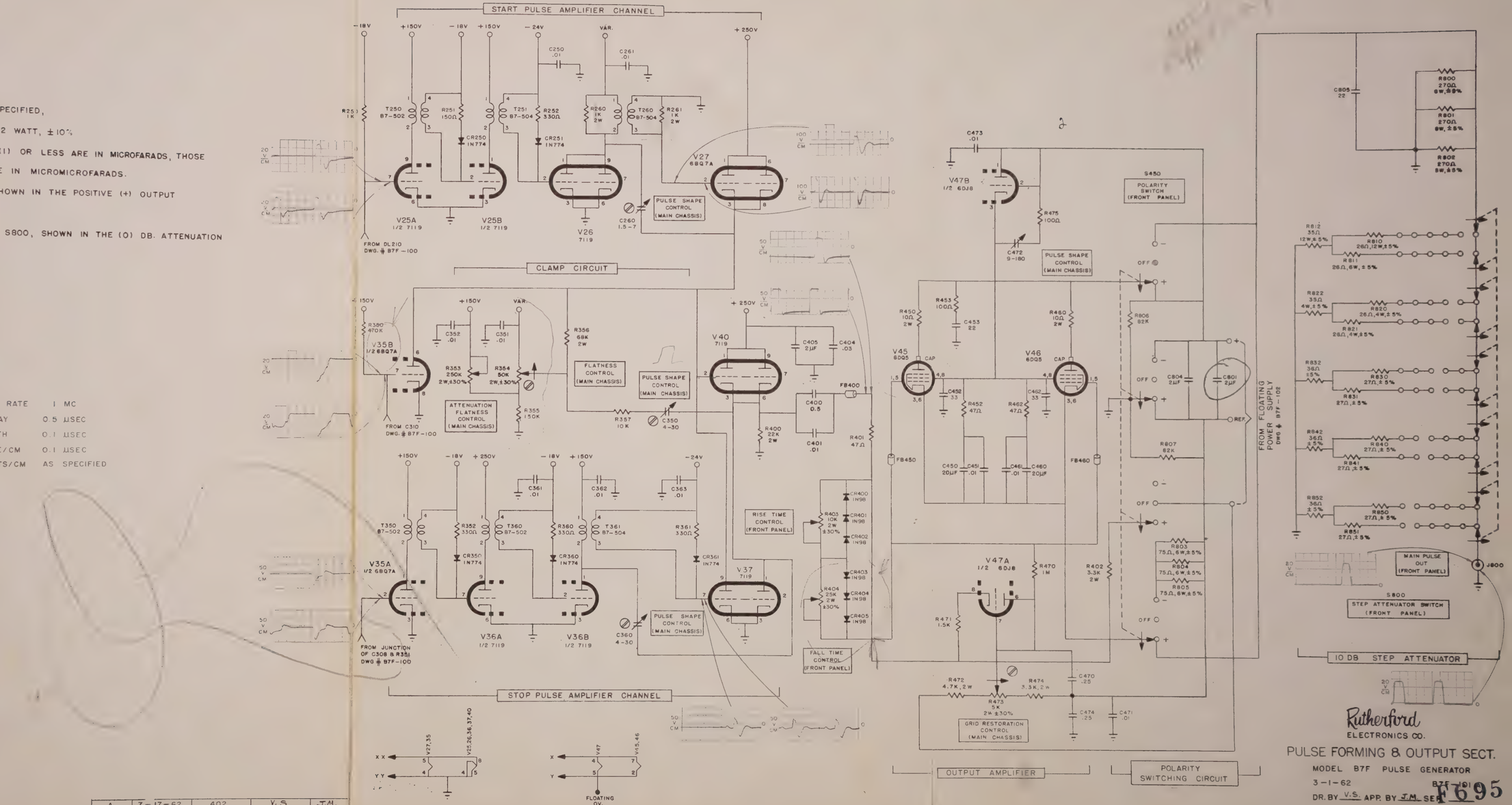
REP. RATE, DELAY & WIDTH SECT.
MODEL B7F PULSE GENERATOR
3-7-62 B7F-100
DR. BY V.S. APP. BY J.M. SER. F695

NOTES: UNLESS OTHERWISE SPECIFIED,

1. ALL FIXED RESISTORS ARE 1/2 WATT, ±10%
2. ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS, THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS.
3. POLARITY SWITCH, S450, SHOWN IN THE POSITIVE (+) OUTPUT PULSE POSITION.
4. STEP ATTENUATOR SWITCH, S800, SHOWN IN THE (0) DB. ATTENUATION POSITION.

WAVEFORMS

PULSE GENERATOR SETTING:	REP. RATE	1 MC
	DELAY	0.5 μSEC
	WIDTH	0.1 μSEC
OSCILLOSCOPE SETTING:	TIME/CM	0.1 μSEC
(TEKTRONIX TYPE 541A)	VOLTS/CM	AS SPECIFIED



A	7-17-62	402	V.S.	J.M.
CH. LTR.	DATE	C.O. NO.	BY	APP.

Rutherford ELECTRONICS CO.

PULSE FORMING & OUTPUT SECT.

MODEL B7F PULSE GENERATOR

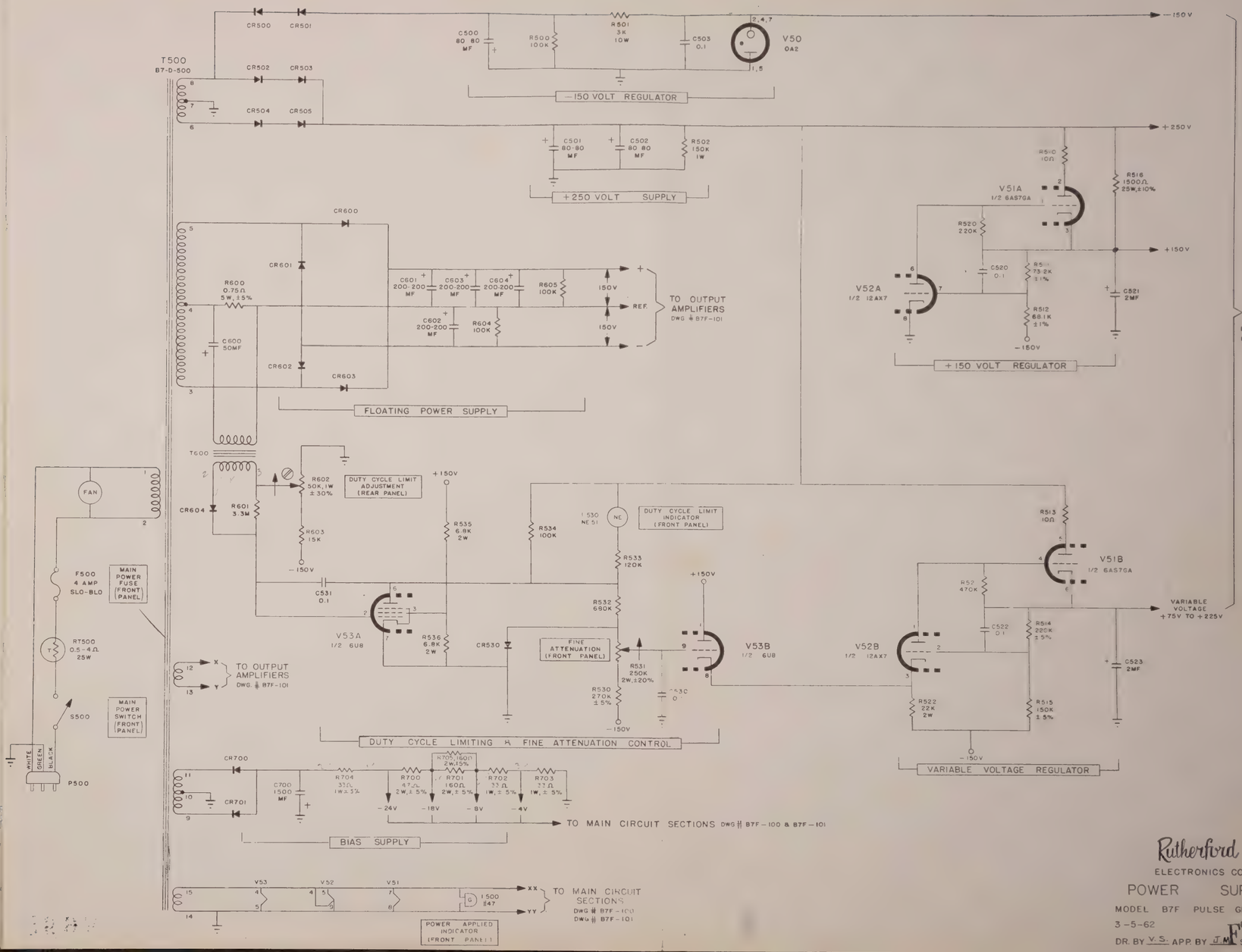
3-1-62 B7F-101

DR. BY V.S. APP. BY J.M. SET

F695

NOTES: UNLESS OTHERWISE SPECIFIED,

1. ALL FIXED RESISTORS ARE 1/2 WATT, ±10%
2. ALL CAPACITOR VALUES ONE (1) OR LESS ARE IN MICROFARADS, THOSE GREATER THAN ONE (1) ARE IN MICROMICROFARADS.



A	7-17-62	402	V.S.	J.M.
CHG. LT.	LTR.	CHG. NO.	BY	APP.

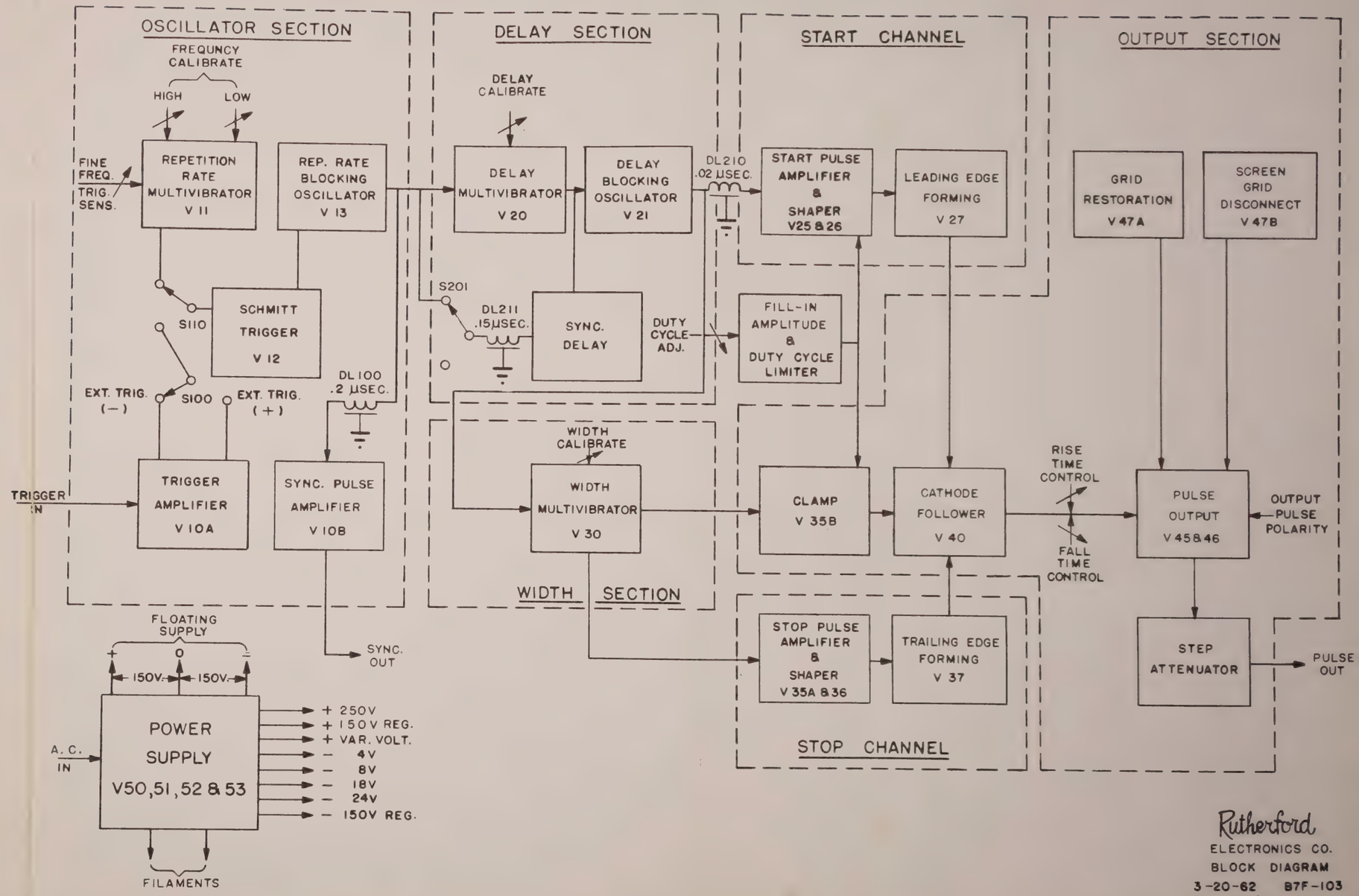
Rutherford
ELECTRONICS CO.

POWER SUPPLY

MODEL B7F PULSE GENERATOR

3-5-62 B7F-100-D

DR. BY V.S. APP. BY J.M. SER. F695



Rutherford
ELECTRONICS CO.
BLOCK DIAGRAM
3-20-62 B7F-103
DR. BY Y.S. APP. BY

A highly versatile, precision, general purpose instrument designed to meet the rigid standards of research and development from biological research at low repetition rates, to transistors, transistor circuits, and magnetic core research at high repetition rates.

MODEL **B-7B**

Rutherford PULSE GENERATOR

DESIGNED FOR...

HIGH PERFORMANCE AND LONGER LIFE AT LOW COST

featuring...

EASE OF MAINTENANCE AND OPERATION

- PRINTED CIRCUIT BOARDS with all components clearly identified by schematic symbol numbers.
- A NEW STABILIZED NOISE-FREE REPETITION RATE SECTION.
- VARIABLE RISE TIME CONTROL.
- A NEW SINGLE UNIT CONSTRUCTION for years of trouble-free operation.
- RACK MOUNTABLE.
- FEW TUBES MEAN FEW REPAIRS.
- PROTECTED AGAINST OVER-LOAD.
- COMPLETE COVERAGE:

Rep Rate	Delay	Width
High to Low	Short to Long	Narrow to Wide

Rutherford
ELECTRONICS CO.
8944 Lindblade Street,
Culver City, California
Telephone: UPton 0-7393
TWX-CVR-CY-4133

SPECIFICATIONS .... MODEL B-7B

REPETITION RATE:	20 c/s to 2 mc/s, continuously variable in five ranges.
EXTERNAL TRIGGER:	Unit may also be triggered from an external source by a pos. or neg., 20 volt pulse at rep. rates to 2 mc/s.
	Note: The fast rise time quality of the B7B sync. pulse allows the triggering of one or more B7Bs from the sync. pulse of a master unit at all rep. rates.
DELAY:	0.0 μ sec. to 10,000 μ sec., continuously variable in five ranges. (Referenced to the sync. pulse.)
WIDTH:	0.05 μ sec. to 10,000 μ sec., continuously variable in five ranges. (Measured at the 50% amplitude points.)
AMPLITUDE:	50 volts, minimum, into 50 ohms.
DUTY FACTOR:	30%, maximum, at full output amplitude. Automatic limiting circuitry reduces the output amplitude at duty factors greater than 30%. Unit may be safely operated to approx. a 70% duty factor. Output amplitude is approx. 35 volts at 50% duty factor and approx. 20 volts at 70%.
ATTENUATION:	0 to 60 db. down, continuously variable.
RISE TIME:	0.015 μ sec., or less.
FALL TIME:	0.015 μ sec., or less.
	Note: Rise and fall time may be simultaneously degraded to approx. 1 μ sec. by front panel control.
POLARITY:	Positive or negative, but not simultaneously.
OVERSHOOT & UNDERSHOOT:	5%, maximum, at full amplitude.
DROOP:	0-100 μ sec. wide pulse — negligible. 100-1,000 μ sec. wide pulse — 15%, max. 1,000-10,000 μ sec. wide pulse — 25%, max.
SYNC. PULSE OUT:	Amplitude — .10 volts, min. Width — 0.05 μ sec., min. Rise time — 0.03 μ sec., max. Polarity — Positive.
SIZE:	19" wide, 8¾" high, 13" deep.
WEIGHT:	Approx. 42 lbs., net 53 lbs., shipping wt.
POWER REQ'D:	115 volts, 3.26 amps., 50-60 c/s, 375 watts.
PRICE:	$720.00, F.O.B. Culver City, California.

All data subject to change without notice.

Rutherford
ELECTRONICS CO.
8944 Lindblade Street,
Culver City, California
Telephone: UPton 0-7393
TWX-CVR-CY-4133

Representatives and Service in the major cities of the World

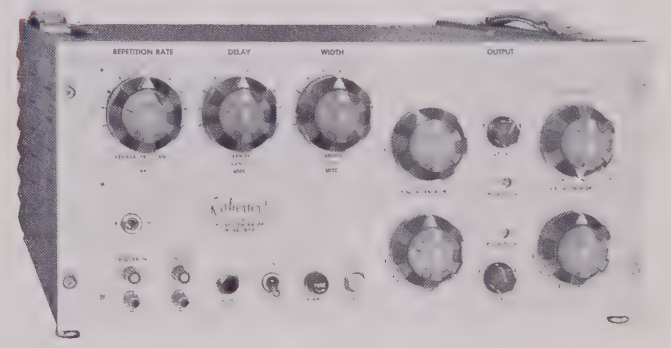
accurate research starts with RUTHERFORD pulse instrumentation

pulse generators / pulse systems / accurate time delay generators

Rutherford presents...

THE MODEL B-7D

PULSE GENERATOR

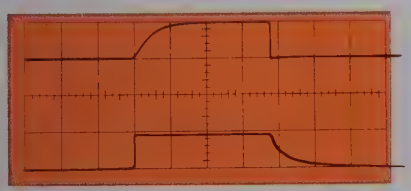


The NEW MODEL B-7D incorporates all of the time-proven specifications of the popular MODEL B-7B . . .

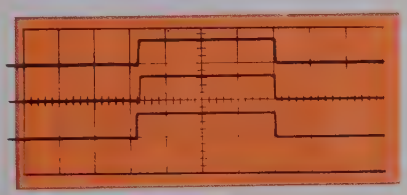
PLUS THREE NEW FEATURES

- **Simultaneous Positive and Negative Output Pulses**
  The two pulses available at front panel connectors are identical in all respects except for being opposite in polarity.
- **Separate and Independent Rise and Fall Time Controls**
  The rise or fall time of either pulse may be degraded without affecting the remaining rise and fall times.
- **DC Level Control on both outputs**
  The DC level of each output may be set to zero, at all duty factors up to 30%, by front panel control.

Double exposure photograph showing independent degradation of (a) rise time and (b) fall time.



Triple exposure photograph showing the DC level of an output pulse at three different settings.



Rutherford
ELECTRONICS CO.
P.O. Box 472
Culver City, California
Telephone: UPton 0-7393
TWX-CVR-CY-4133

SPECIFICATIONS . . . . MODEL B-7D

REPETITION RATE:	20 c/s to 2 mc/s, continuously variable in five ranges.
EXTERNAL TRIGGER:	Unit may also be triggered from an external source by a pos. or neg., 20 volt pulse at rep. rates to 2 mc/s.
	Note: The fast rise time quality of the B-7D sync. pulse allows the triggering of one or more B-7D's from the sync. pulse of a master unit at all rep. rates.
DELAY:	0.0 μ sec. to 10,000 μ sec., continuously variable in five ranges. (Referenced to the sync. pulse.)
WIDTH:	0.05 μ sec. to 10,000 μ sec., continuously variable in five ranges. (Measured at the 50% amplitude points.)
AMPLITUDE:	50 volts, minimum, into 50 ohms. (both output pulses)
DUTY FACTOR:	30%, maximum, at full output amplitude. Automatic limiting circuitry reduces the output amplitude at duty factors greater than 30%. Unit may be safely operated to approx. a 70% duty factor. Output amplitude is approx. 35 volts at 50% duty factor and approx. 20 volts at 70%.
ATTENUATION:	0 to 60 db. down, continuously variable.
RISE TIME:	0.015 μ sec., or less.
FALL TIME:	0.015 μ sec., or less.
	Note: Rise and fall time of each output pulse may be independently degraded to approx. 1 usec.
POLARITY:	Positive and negative, simultaneously.
OVERSHOOT & UNDERSHOOT:	5%, maximum, at full amplitude.
DROOP:	0-100 μ sec. wide pulse — negligible. 100-1,000 μ sec. wide pulse — 15%, max. 1,000-10,000 μ sec. wide pulse — 25%, max.
DC LEVEL:	The DC level of each output may be set to zero, at all duty factors up to 30%, by front panel control.
SYNC. PULSE OUT:	Amplitude — .10 volts, min. Width — 0.05 μ sec., min. Rise time — 0.03 μ sec., max. Polarity — Positive.
SIZE:	19" wide, 8¾" high, 18 5/8" deep.
WEIGHT:	Approx. 60 lbs., net 70 lbs., shipping wt.
POWER REQ'D:	115 volts, 3.26 amps., 50-60 c/s, 375 watts.
PRICE:	$1200.00 F.O.B. Culver City, California.

All data subject to change without notice.

Rutherford

P.O. Box 472
Culver City, California
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TWX-CVR-CY-4133

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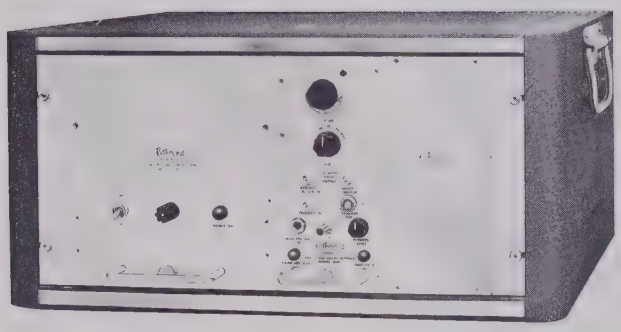
accurate research starts with [illegible] pulse instrumentation

Rutherford



MODEL A9

A9-001

TIME DELAY SYSTEMS

The Rutherford Model A9 Time Delay Systems features all new transistorized circuitry, to make it the most reliable, highly accurate time delay generator available today.

Rutherford

A NEW CONCEPT IN PULSE AND TIME DELAY CIRCUITRY

The Model A9 Time Delay Systems and Model B9 Pulse Generating Systems represent a dynamic new approach to pulse and time delay circuitry. Choose from these groups of modules to fulfill all of your present and future pulse and time delay requirements.

New [illegible] ized circuitry is featured wherever feasible.

REPETITION RATE MODULES

MODULE NO.	REP. RATE RANGE (KC/Sec.)	ACCURACY (% of F.S.)	JITTER (% of F.S.)	OUTPUTS (VOLTS, OPEN CIRCUIT)		POWER SUPPLY REQ'D	PRICE	REMARKS
				SYNC. PULSE	TRIG. OUT			
RR001	.001 - 100	±1	.05 max.	+10	−7	LVP001	$445	use 5-60V. pulse or 10-70V. sine wave for external trigger

DELAY MODULES

MODULE NO.	DELAY RANGE (μsec.)	ACCURACY (% of F.S.)	JITTER (% of F.S.)	TRIG. REQ'D (VOLTS)	OUTPUTS (VOLTS, OPEN CIRCUIT)				POWER SUPPLY REQ'D	PRIC
					#1	#2	GATE	RAMP		
DD01	.8 - 100,000	.1 except 10 μsec. range	.006% or .01 μsec.	5-60 pulse 10-70 sine wave	+35	+12	+10	+3 to +12	LVP001	$51
DD02	0 - 10,000	1 on 10 μsec. range .5 all other ranges (not specified below 1 μsec.)	.01% or .02 μsec.	−7	+20	−7	+10	+3 to +12	LVP001	$40

Printed circuitry is fea-

Hard tube circuitry is
high speed requirements
demand it.

WIDTH MODULES

All modules specified in the DELAY MODULE section are available as WIDTH MODULES. Simply replace the D in the part no. with a W.

Complete specifications on each Model are available on request.

PULSE FORMING MODULES

MODULE NO.	AMP. (VOLTS)	Zo (ohms)	tr (μsec.)	tf (μsec.)	ATTEN. (db)	POLARITY	POWER SUPPLY REQ'D	PRICE
PFDX1	50	50	.015	.015	60	+ or −	HVP001	$405

POWER SUPPLY MODULES

MODULE NO.	POWER REQUIRED	OUTPUTS (VOLTS/ma)	PRICE
LVP001	105-125 V.ac. 50-60 cps. 40 watts	+22.5/400, −22.5/400, +12/150 −12/150, +6/10, −3/10	$315
HVP001	105-125 V.ac. 50-60 cps. 375 watts	+250/90, +150/280, +var. +150 (float)/1.6 amp., −150 (float)/200 −150/5, −20/30, −18/35, 6.3 ac/8.5 amp. 6.3 ac (float)/6 amp.	$290

Let us know your present and future pulse and time delay requirements. They can be fulfilled to the letter with Model A9 or B9 systems.

free service.

SPECIFICATIONS:
MODEL A9-001

DELAY:

The Model A9-001 is a highly accurate time delay generator which exhibits the following characteristics:

RANGE: The output pulse may be delayed continuously from 0.8 to 100,000 microseconds (with respect to the input trigger) in five ranges:

0.8 microseconds to 10 microseconds
10 microseconds to 100 microseconds
100 microseconds to 1,000 microseconds
1,000 microseconds to 10,000 microseconds
10,000 microseconds to 100,000 microseconds

ACCURACY: The delay dial setting is accurate to the following tolerances, except for the 0.8 to 10 microseconds range for which no accuracy tolerance is specified:

After calibration: ± 0.1% of full scale.

JITTER: Time jitter introduced by the generator is less than 0.006% of full scale or 0.01 microseconds, whichever is greater.

DUTY FACTOR EFFECTS: Errors in delay may be introduced with increased duty factors. The table below indicates approximate error at various duty factors on the 100 to 1,000 microsecond range:

Duty Factor	Error	Duty Factor	Error
.02	Ref.	.75	3.6%
.05	1.01%	.90	5.1%
.20	0.6%	.95	6.4%
.50	2.2%		

Note: The duty factor must be limited to allow at least 3 microseconds recovery time.

LINE VOLTAGE VARIATION EFFECTS: A change of line voltage from 105 to 125 volts, RMS, changes the delay by 0.15%, maximum.

TEMPERATURE VARIATION EFFECTS: A change in ambient temperature will have the following effect on time delay:

0.8 to 10 microsecond range—a delay drift of 1% of full scale, maximum, over the range of 0°C. to +35°C.

All other ranges—a delay drift of 0.5% of full scale, maximum, over the range of −10°C. to +50°C.

MODULATION: Delay may be modulated by the introduction of an external voltage. A 2.8 to 12 volt change will vary the delay from minimum to maximum on any range.

OUTPUTS:

The following output wave forms are available at the front panel jacks.

BLOCKING OSCILLATOR OUTPUT: The blocking oscillator output occurs at the end of the time delay setting and exhibits the following characteristics:

Amplitude: 30 volts, peak, minimum
Rise Time: .030 microseconds, maximum
Width: .1 microseconds, minimum
Polarity: Positive.
Output Impedance: 50 ohms
Blocking Capacitor: .01 microfarad

MULTIVIBRATOR OUTPUT: A multivibrator output which occurs at the end of the time delay setting is provided for conveniently viewing the delay on an oscilloscope at slow sweep speeds. It exhibits the following characteristics:

Amplitude: 12 volts, peak, minimum Width:

Delay Range	Width
0.8 to 10 microseconds	Approx. 0.5 microsecond
100 microseconds	Approx. 5 microseconds
1,000 microseconds	Approx. 36 microseconds
10,000 microseconds	Approx. 120 microseconds
100,000 microseconds	Approx. 350 microseconds

Polarity: Positive
Output Impedance: 2K ohms
Blocking Capacitor: .01 microfarad

GATE OUTPUT: A gate output is provided which turns on with the input trigger and off at the end of the time delay. It exhibits the following characteristics:

Amplitude: 10 volts, peak, minimum
Polarity: Positive
Output Impedance: 100 ohms

RAMP OUTPUT: A ramp output is provided which starts with the trigger and turns off at the end of the time delay. It exhibits the following characteristics:

Amplitude: +3 to +12 volts
Polarity: Positive—going with delay.
Output Impedance: 470 ohms

INPUT TRIGGER:

The following trigger is required from an external source to initiate the time delay.

PULSE: The unit may be triggered by a pulse exhibiting the following characteristics:

Amplitude: 5 to 60 volts, peak
Width: 0.05 microseconds or greater
Polarity: Positive or Negative
Frequency: Single shot to 290KC
Note: Duty cycle limitation

SINE WAVE: The unit may also be triggered by a sine wave exhibiting the following characteristics:

Amplitude: 10-70 volts, peak to peak
Frequency: 5 cps to 290 KC

A trigger sensitivity control allows reliable triggering from an external source, regardless of waveform.

INPUT IMPEDANCE: 50K ohms, blocking capacitor for 100 volts

MISCELLANEOUS:

POWER REQUIRED: 105 to 125 volts, 0.35 amps., 50 to 60 cps., 40 watts
WEIGHT: Approx. 55 lbs.
DIMENSIONS: 10½" high x 22" wide x 15" deep
PRICE: $1,155.00 F.O.B. Culver City, California

All data subject to change without notice.

Bulletin A9-623-5M

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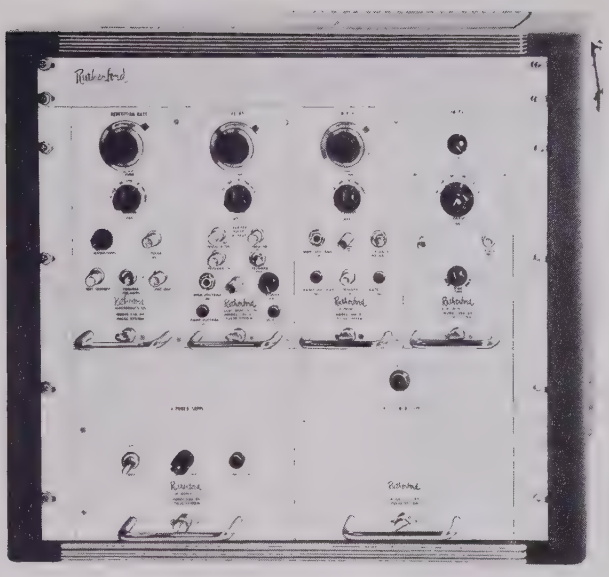

MODEL B9

B9-001

PULSE SYSTEMS

The Rutherford Model B9 Pulse Generating Systems is a precision pulse generator and features the plug-in module type construction to make it the finest, most reliable pulse generator available today.

Rutherford

A NEW CONCEPT IN PULSE AND TIME DELAY CIRCUITRY

New [illegible] ized circuitry is featured wherever feasible

The Model A9 Time Delay Systems and Model B9 Pulse Generating Systems represent a dynamic new approach to pulse and time delay circuitry. Choose from these groups of modules to fulfill all of your present and future pulse and time delay requirements.

REPETITION RATE MODULES

MODULE NO.	REP. RATE RANGE (KC/Sec.)	ACCURACY (% of F.S.)	JITTER (% of F.S.)	OUTPUTS (VOLTS, OPEN CIRCUIT)		POWER SUPPLY REQ'D	PRICE	REMARKS
				SYNC. PULSE	TRIG. OUT			
RR001	.001 - 100	±1	.05 max.	+10	−7	LVP001	$445	use 5-60V. pulse or 10-70V. sine wave for external trigger

DELAY MODULES

MODULE NO.	DELAY RANGE (μsec.)	ACCURACY (% of F.S.)	JITTER (% of F.S.)	TRIG. REQ'D (VOLTS)	OUTPUTS (VOLTS, OPEN CIRCUIT)				POWER SUPPLY REQ'D	PRIC
					#1	#2	GATE	RAMP		
D001	.8 - 100,000	.1 except 10 μsec. range	.006% or .01 μsec.	5-60 pulse 10-70 sine wave	+35	+12	+10	+3 to +12	LVP001	$51
D002	0 - 10,000	1 on 10 μsec. range .5 all other ranges (not specified below 1 μsec.)	.01% or .02 μsec.	−7	+20	−7	+10	+3 to +12	LVP001	$40

WIDTH MODULES

All modules specified in the DELAY MODULE section are available as WIDTH MODULES. Simply replace the D in the part no. with a W.

Printed circuitry is fea-

Hard tube circuitry is
high speed requirements
demand it.

Complete specifications on each Model are available on request.

PULSE FORMING MODULES

MODULE NO.	AMP. (VOLTS)	Zo (ohms)	tr (μsec.)	tf (μsec.)	ATTEN. (db)	POLARITY	POWER SUPPLY REQ'D	PRICE
PF001	50	50	.015	.015	60	+ or −	HVP001	$405

POWER SUPPLY MODULES

MODULE NO.	POWER REQUIRED	OUTPUTS (VOLTS/ma)	PRICE
LVP001	105-125 V.ac. 50-60 cps. 40 watts	+22.5/400, −22.5/400, +12/150 −12/150, +6/10, −3/10	$315
HVP001	105-125 V.ac. 50-60 cps. 375 watts	+250/90, +150/280, +var. +150 (float)/1.6 amp., −150 (float)/200 −150/5, −20/30, −18/35, 6.3 ac/8.5 amp. 6.3 ac (float)/6 amp.	$290

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Let us know your present and future pulse and time delay requirements. They can be fulfilled to the letter with Model A9 or B9 systems.

SPECIFICATIONS / MODEL B9-001

Bulletin B9 623-5M

REPETITION RATE

RANGE: The internal oscillator is continuously variable from 1 cycle per sec. to 100 kilocycles, in 5 ranges.

1 cps — 10 cps
10 cps — 100 cps
100 cps — 1kc
1 kc — 10 kc
10 kc — 100 kc

DIAL CALIBRATION: 1,000 divisions per range.

ACCURACY: The repetition rate dial setting is accurate to the following tolerance:
After Calibration: ±1% of full scale.

JITTER: Pulse to pulse jitter introduced by the generator is approx. 0.05% of full scale.

LINE VOLTAGE VARIATION EFFECTS: A change of line voltage from 105 to 125 V, RMS, changes the frequency by 0.13%.

TEMPERATURE VARIATION EFFECTS: A change in ambient temperature will have the following effect on the frequency: A frequency drift of 1% of full scale, max., over the range of 0°C to +50°C on all ranges.

MODULATION: Frequency may be modulated by the introduction of an external voltage. A change of approx. +1.1 to +3.4 V. will vary the frequency from 0.1 to full scale on all ranges.

SINGLE PULSE: A micro switch provides a single pulse at each of the outputs.

EXTERNAL TRIGGER INPUT:

Pulse: The unit may be triggered by a pulse exhibiting the following characteristics:
Amplitude: 5 to 60 V., peak.
Width: 0.05 usec. or greater
Minimum Rate of Rise: 120 V/sec
Polarity: Positive or negative
Frequency: Single shot to 290 kc

Sine Wave: The unit may also be triggered by a sine wave exhibiting the following characteristics:
Amplitude: 10 - 70 V, peak to peak
Frequency: 5 cps to 290 kc

Input Impedance: 50K ohms, blocking capacitor for 100 V.

SYNC PULSE OUT: Blocking oscillator output pulse through an emitter follower is delayed from the rep. rate trigger pulse by approx. 2 usec. and exhibits the following characteristics:
Amplitude: 10 V, min., open circuit
Polarity: Positive
Rise Time: 0.05 usec.
Width: 0.2 usec.
Output Impedance: 390Ω
Blocking Capacitor: 0.01 ufd., 500V

WIDTH

RANGE: The main pulse width is continuously variable from 0.05 usec. to 10,000 usec. in 5 ranges:

0.05 usec. — 1 usec.
1 usec. — 10 usec.
10 usec. — 100 usec.
100 usec. — 1,000 usec.
1,000 usec. — 10,000 usec.

DIAL CALIBRATION: 1,000 divisions per range.

ACCURACY: The width dial setting is accurate to the following tolerances, except for the 0.05 usec. to 1 usec. range for which no accuracy tolerance is specified:
After Calibration:
1 - 10 usec. range: ±1% of full scale
All other ranges: ±0.5% of full scale

JITTER: Time jitter introduced by the width module is less than 0.01% of full scale or 0.02 usec., whichever is greater.

LINE VOLTAGE VARIATION EFFECTS: A change of line voltage from 105 to 125 V, RMS, changes the pulse width by 0.15%, max.

TEMPERATURE VARIATION EFFECTS: A change in ambient temp. will have the following effects on the pulse width, except on the 0.05 - 1 usec. range for which no temp. variation effect is specified.
1 - 10 usec. range: a pulse width drift of 1% of full scale, max., over the range of 0°C to +35°C
All other ranges: a pulse width drift of 0.5% of full scale, max., over the range of −10°C to +50°C

MODULATION: Pulse width may be modulated by the introduction of an external voltage. A change from approx. +2.8 to +12 V. will vary the pulse width from min. to max. on any range.

GATE OUTPUT: A gate output is provided which turns on at the end of the delay and turns off at the end of the pulse width. It exhibits the following characteristics:
Amplitude: 10 V, peak, min., open circuit
Polarity: Positive Output Impedance: 100Ω

RAMP OUTPUT: A ramp output is provided which starts at the end of the delay and turns off at the end of the pulse width. It exhibits the following characteristics:
Amplitude: +3 to +12 V, at maximum width of range, open circuit
Polarity: Positive—going with width Output Impedance: 470Ω

DELAY

RANGE: The main pulse delay is continuously variable, with respect to the sync pulse out, from 0.0 usec. to 10,000 usec., in 5 ranges:

0 — 1 usec.
1 usec. — 10 usec.
10 usec. — 100 usec.
100 usec. — 1,000 usec.
1,000 usec. — 10,000 usec.

DIAL CALIBRATION: 1,000 divisions per range.

ACCURACY: The delay dial setting is accurate to the following tolerance, except for the 0.0 usec. to 1 usec. range for which no accuracy tolerance is specified:
After Calibration:
1-10 usec. range: ±1% of full scale
All other ranges: ±0.5% of full scale

JITTER: Time jitter introduced by the delay module is less than 0.01% of full scale or 0.02 usec., whichever is greater.

DUTY FACTOR EFFECTS: Errors in delay may be introduced with increased duty factors. Table below indicates approx. error at various duty factors on the 100 to 1,000 usec. range.

DUTY FACTOR	ERROR	DUTY FACTOR	ERROR
.02	Ref.	.75	3.6%
.05	0.01%	.90	5.1%
.20	0.6%	.95	6.4%
.50	2.2%		

Note: Duty factor must be limited to allow at least 3 usecs. recovery time.

LINE VOLTAGE VARIATION EFFECTS: A change of line voltage from 105 to 125 V, RMS, changes the delay by 0.15%, max.

TEMPERATURE VARIATION EFFECTS: A change in ambient temp. will have the following effect on the delay, except for the 0.0 - 1 usec. range for which no temp. variation effect is specified:
1 - 10 usec. range: a delay drift of 1% of full scale, max., over the range of 0°C to +35°C
All other ranges: a delay drift of 1% of full scale, max., over the range of −10°C to +50°C

MODULATION: Delay may be modulated by the introduction of an external voltage. A change from approx. +2.8 to +12 V will vary the delay from min. to max. on any range.

GATE OUTPUT: A gate output is provided which turns on with the rep. rate trigger pulse and off at the end of the delay. It exhibits the following characteristics:
Amplitude: 10 V, peak, min., open circuit
Polarity: Positive Output Impedance: 100Ω

RAMP OUTPUT: A ramp output is provided which starts with the rep. rate trigger pulse and stops at the end of the delay. It exhibits the following characteristics:
Amplitude: +3 to +12 V, at max. delay of range, open circuit
Polarity: Positive—going with delay Output Impedance: 470Ω

MAIN PULSE OUTPUT

AMPLITUDE: 50 V, minimum, into a 50Ω load.

POLARITY: Positive or negative, but not simultaneously.

RISE TIME: 0.015 usec., or less.

FALL TIME: 0.015 usec., or less.
NOTE: Both rise and fall time may be degraded simultaneously to approx. 1 usec.

STEP ATTENUATOR: 5 steps of 10db attenuation.

FINE ATTENUATION CONTROL: 10db variable attenuation through any 10db step.

OVERSHOOT AND UNDERSHOOT: 5% max., except when pulse is attenuated more than 30db with the 10db step attenuator; 30%, max., at 50db down.

DROOP: 0.05 - 100 usec. wide pulse — Negligible.
100 - 1,000 usec. wide pulse — 15%, max.
1,000 - 10,000 usec. wide pulse — 25%, max.

DUTY FACTOR: 30% at full amplitude.

OUTPUT IMPEDANCE: 50Ω

MISCELLANEOUS SPECIFICATIONS

POWER REQUIRED: 105-125 V, 3.25 amps, 50-60 cps, 340 watts.

VENTILATION: Filtered, forced air.

DIMENSIONS: 19" H x 22" W x 18" D.

WEIGHT: 100 lbs., net.

ACCESSORIES INCLUDED: One instruction manual.

PRICE: $1,975 f.o.b. Culver City, California.

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PULSE GENERATOR / MODEL B5-A

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INSTRUMENTS

FEATURING:

High Repetition Rate with no greater than 8 Millimicroseconds Rise and Fall Time operating from 1 cps to 10 megacycles.

The Model B5-A, built to the most exacting standards of precision engineering, offers an unparalleled combination of good, clean pulses and high repetition rate and fast rise and fall times. The unit provides an electronic pulse delay that can be set to zero or is continuously variable from .030 microseconds to 500 microseconds in five ranges. Pulse width is continuously variable from .02 to 12.5 microseconds in four ranges.

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Post Office Box 472, Culver City, California • Area Code 213 Telephone 870-7393 TWX 213-836-0407

SPECIFICATIONS B-5A

MAIN PULSE: PULSE WIDTH: continuously variable from .02 microsecond to 12.5 microseconds (duty factor limited to 20%) in four ranges:

.02 to .1 microsecond
.1 to .5 microsecond
.5 to 2.5 microseconds
2.5 to 12.5 microseconds

AMPLITUDE: 40 volts positive, 45 volts negative.

ATTENUATOR: 60 db in ½ db steps.

RISE AND FALL TIME: no greater than 8 millimicroseconds.

POLARITY: both positive and negative pulses simultaneously available.

OUTPUT IMPEDANCE: 185 ohms (the instrument must be terminated for proper pulse shape).

PERCENT DROOP: no greater than 6%.

SYNCHRONIZING PULSE OUT: 10 volts, positive.

RISE TIME: less than .02 microsecond.

WIDTH: .03 microsecond.

EXERNAL TRIGGER: Pulse Required: 10 volts minimum with rise time less than .05 microsecond.

PULSE REPETITION RATE: Continuously variable from 1 cycle/sec to 10 mc/sec in seven ranges:

1 c to 10 c
10 c to 100 c
100 c to 1 kc
1 kc to 100 kc
10 kc to 100 kc
100 kc to 1 mc
1 mc to 10 mc

DELAY: A fixed delay of .1 microsecond occurs between the synchronizing pulse out and the main pulse.

ELECTRONIC PULSE DELAY: can be set to zero or is continuously variable from 0.030 μsec. to 500 μsecs in 5 ranges.

Note: Pulse delay is limited to approximately 20% of the pulse spacing.

POWER REQUIRED: 105-125 volts, 50-60 cycles, 600 watts.

CONNECTORS:

Sync. Pulse Out—type BNC.
External Trigger—type BNC.
Main Pulse—type C.

DIMENSIONS: 23" high, 23" wide, 16" deep.

WEIGHT: 110 pounds.

ACCESSORIES SUPPLIED

1 unit extension cable.
1 5-ft. output cable (type RG 114/U)
1 185 ohm non-inductive resistor.
1 185 ohm termination assembly.
1 instruction manual.

PRICE: $2,400.00 F.O.B. Culver City, California.

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